Precision Cylinder

Series MTS

ø8, ø12, ø16, ø20, ø25, ø32, ø40

How to Order

ø8 MTS 8 — 20 □ □ — A90L □

ø12 to ø40 MTS 20 — 100 □ □ — A90L □

Bore size

8	8mm

Port direction

Nil	Standard piping type
P	Axial piping type

Bore size

12	12mm
16	16mm
20	20mm
25	25mm
32	32mm
40	40mm

Number of auto switches

Nil	2 pcs.
S	1 pc.

Auto switch type

Nil	Without auto switch

∗ Refer to the table below for auto switch part numbers.

For ø8 cylinders with auto switch, some auto switches cannot be mounted depending on piping direction and stroke size. Refer to "Auto Switch Mounting Strokes for ø8" on page 11.

Cylinder stroke (mm)
Refer to the standard stroke table on page 2.

End lock

Nil	Without end lock
R	With rear end lock

Rod end configuration

Nil	Rod end female threads
M	Rod end male threads

Applicable auto switches/Refer to pages 14 through 18 for detailed auto switch specifications.

Type	Special functions	Electrical entry	Indicator light	Wiring (output)	Load voltage			Auto switch model		Lead wire length (m)			Applicable load	
								Electrical entry direction		0.5 (Nil)	3 (L)	5 (Z)		
					DC		AC	Perpendicular	In-line					
Reed switch	—	Grommet	No	2 wire	24V	5V 12V	100V or less	**A90V**	**A90**	●	●	—	IC circuit	Relay, PLC
			Yes			12V	100V	**A93V**	**A93**	●	●	—	—	
				3 wire (NPN equiv.)	—	5V	—	**A96V**	**A96**	●	●	—		—
Solid state switch	—	Grommet	Yes	3 wire (NPN)	24V	5V 12V	—	**F9NV**	**F9N**	●	●	○	IC circuit	Relay, PLC
								F8N**	—	●	●	○		
				3 wire (PNP)				**F9PV**	**F9P**	●	●	○		
								F8P**	—	●	●	○		
				2 wire		12V		**F9BV**	**F9B**	●	●	○	—	
								F8B**	—	●	●	○		
	Diagnostic indication (2 color indicator)			3 wire (NPN)		5V 12V		**F9NWV**	**F9NW**	●	●	○	IC circuit	
				3 wire (PNP)				**F9PWV**	**F9PW**	●	●	○		
				2 wire		12V		**F9BWV**	**F9BW**	●	●	○	—	

∗ Lead wire length symbols 0.5m ..... Nil (Ex.) A93
3m ..... L (Ex.) A93L
5m ..... Z (Ex.) F9NWZ

∗ Solid state auto switches marked with a "○" are produced upon receipt of order.

∗∗ D-F8□ type auto switches are only applicable to ø8 cylinders.

Specifications

Bore size (mm)		8	12	16	20	25	32	40
Spline rod size (mm)		4	6	8	10	13	16	20
Fluid		Air						
Min. operating pressure	Without end lock	0.15MPa	0.12MPa		0.1MPa			
	With end lock *	—	0.17MPa		0.15MPa			
Maximum operating pressure		0.7MPa						
Proof pressure		1.0MPa						
Ambient and fluid temperature		–10 to 60°C (with no freezing)						
Bearing type		Ball spline						
Cushion		Rubber bumper	Air cushion					
Effective cushion length (mm)		—	9	10	11	12	17	17
Lubrication		Non-lube						
Auto switches		Reed switch: D-A9 Solid state switch: D-F9 D-F8	Reed switch: D-A9 Solid state switch: D-F9					
Stroke tolerance		$^{+1.0}_{0}$ mm						
Non-rotating accuracy		0.2° or less (within allowable torque values)	0.1° or less (within allowable torque values)					
Port size		M3 x 0.5	M5 x 0.8	M5 x 0.8	M5 x 0.8	M5 x 0.8	Rc 1/8	Rc 1/8

* Except for lock unit: 0.12MPa for ø12 and 16; 0.10MPa for ø20 to 40

Piston Speed

Bore size (mm)	8	12	16	20	25	32	40
Piston speed (mm/s)	50 to 500	50 to 800					
Allowable kinetic energy J	0.02	0.19	0.32	0.55	0.78	1.6	2.8

End Lock Specifications

Bore size (mm)	12	16	20	25	32	40
Lock position	Rear end only					
Holding force (max.) N	29	53	82	125	211	329
Backlash	1mm					
Manual unlocking	Non-locking type only					

Order Made Specifications

Refer to page 20 for series MTS order made specifications.

Standard Strokes

Bore size (mm)	Standard stroke (mm)
8	5, 10, 15, 20, 25, 30
12, 16	25, 50, 75, 100
20, 25, 32, 40	25, 50, 75, 100, 125, 150, 175, 200

* Strokes other than the above are produced upon receipt of order.

Stud Bolt Part Numbers

Bore size (mm)	Part no.
8	**MT-S8**
12	**MT-S12**
16	**MT-S16**
20	**MT-S20**
25	**MT-S25**
32	**MT-S32**
40	**MT-S40**

* Replacement parts for rod end male threads.
* Rod end nuts are included.

Theoretical Output

(N)

Bore size (mm)	Operating direction	Piston area (mm²)	Operating pressure (MPa) 0.2	0.3	0.4	0.5	0.6	0.7
8	OUT	50	10	15	20	25	30	35
	IN	37	8	11	15	19	22	26
12	OUT	113	23	34	45	57	68	79
	IN	84	17	25	34	42	50	59
16	OUT	201	40	60	80	101	121	141
	IN	150	30	45	60	75	90	105
20	OUT	314	63	94	126	157	188	220
	IN	235	47	71	94	118	141	165
25	OUT	490	98	147	196	245	294	343
	IN	358	72	107	143	179	215	251
32	OUT	804	161	241	322	402	482	563
	IN	603	121	181	241	302	362	422
40	OUT	1,256	251	377	502	628	754	879
	IN	942	188	283	377	471	565	659

⚠**Caution** Do not apply a load that is 50% or more of the theoretical output.

Weights

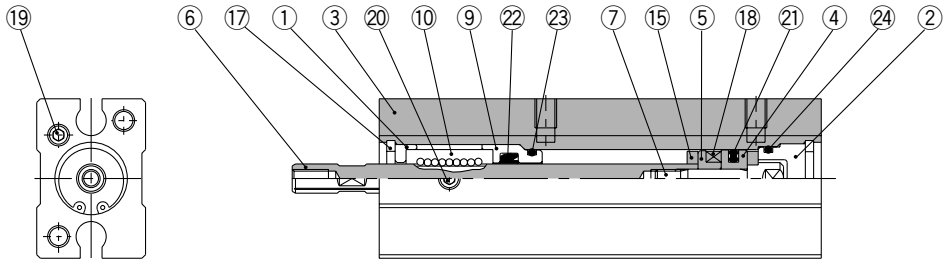
(g)

Model	Standard stroke (mm) 5	10	15	20	25	30	50	75	100	125	150	175	200	End lock additional weight
MTS8	36	40	44	48	52	56	—	—	—	—	—	—	—	—
MTS12	—	—	—	—	138	—	157	175	194	—	—	—	—	29
MTS16	—	—	—	—	186	—	222	258	294	—	—	—	—	34
MTS20	—	—	—	—	350	—	400	450	500	549	599	649	699	42
MTS25	—	—	—	—	487	—	547	608	669	729	790	851	912	55
MTS32	—	—	—	—	918	—	1,000	1,083	1,165	1,247	1,330	1,412	1,495	90
MTS40	—	—	—	—	1,420	—	1,533	1,645	1,758	1,870	1,983	2,095	2,208	133

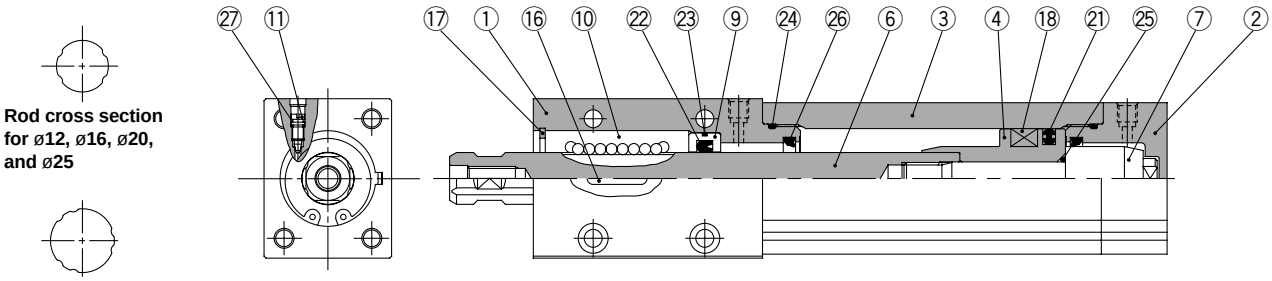
Construction

Basic type

ø8



ø12 to ø40

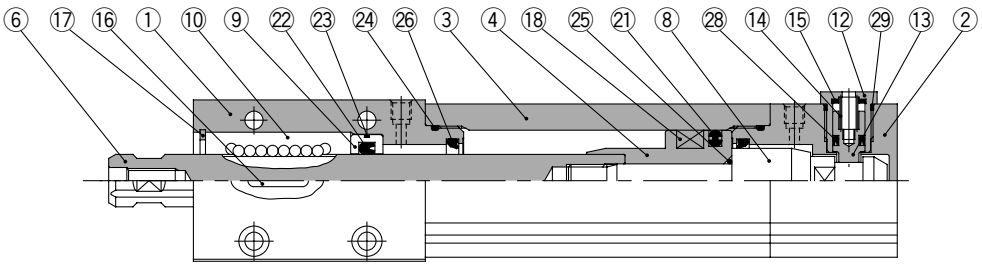


Rod cross section for ø12, ø16, ø20, and ø25

Rod cross section for ø32 and ø40

With end lock

ø12 to ø40



Parts list

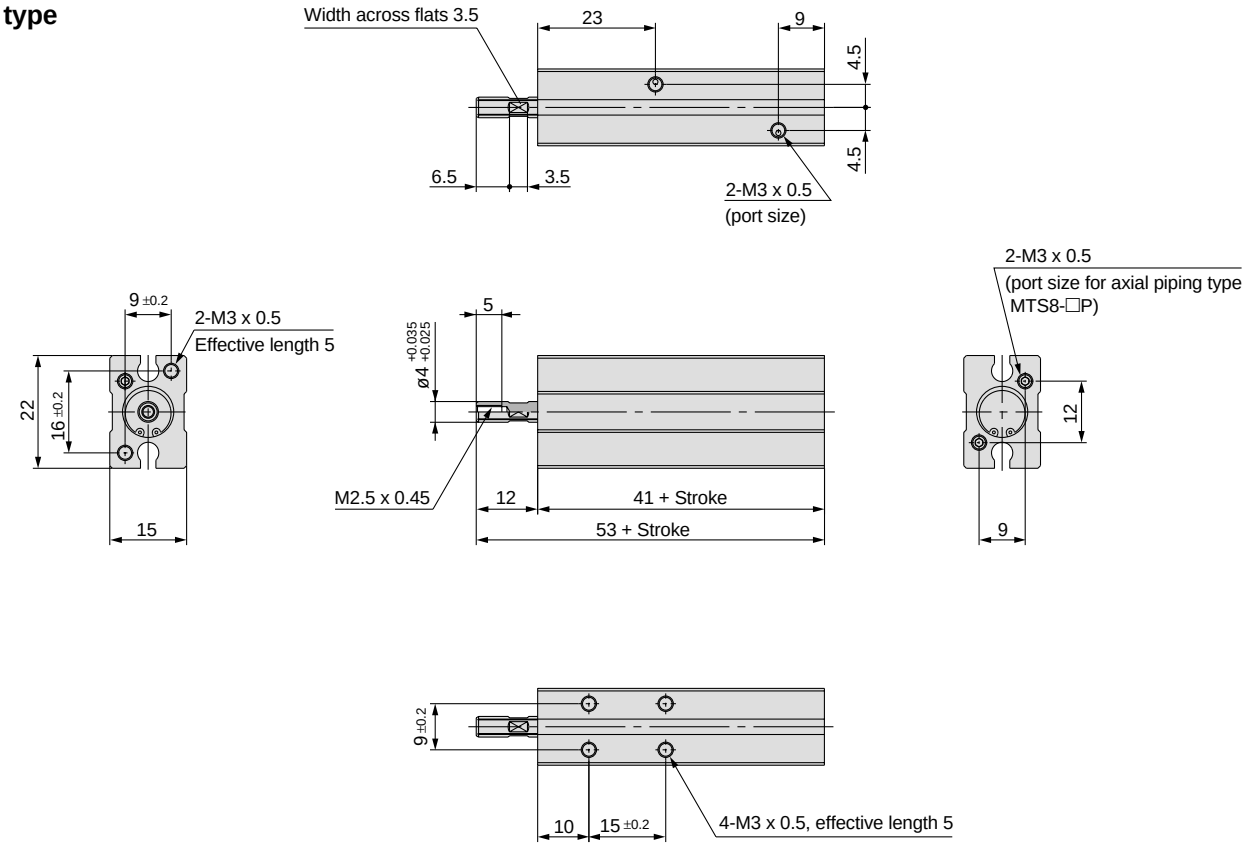
No.	Description	Material	Qty.	Note
1	**Rod cover**	Aluminum alloy	1	Clear anodized
2	**Head cover**	Aluminum alloy	1	Clear anodized
3	**Cylinder tube**	Aluminum alloy	1	Hard anodized
4	**Piston**	Aluminum alloy	1	Chromated
5	**Spacer for switch type**	Aluminum alloy	1	Chromated
6	**Spline rod**	Stainless steel	1	ø8: Quenched
		Carbon steel	1	ø12 to ø40: Quenched/Hard chrome plated
7	**Cushion bolt**	Stainless steel	1	ø8 to ø16
		Carbon steel	1	ø20 to ø40: Zinc chromated
8	**End lock bolt**	Carbon steel	1	Quenched/Zinc chromated
9	**Collar**	Aluminum alloy	1	Chromated
10	**Spline nut**	—	1	
11	**Cushion needle**	Carbon steel	2	Nickel plated
12	**Cap**	Bronze alloy	1	Nickel plated
13	**Lock piston**	Carbon steel	1	Quenched/Hard chrome plated
14	**Lock spring**	Steel wire	1	Zinc chromated

No.	Description	Material	Qty.	Note
15	**Bumper**	Urethane	2	ø8
			1	ø12 to ø40
16	**Key**	Carbon steel	1	
17	**C type snap ring for hole**	Carbon tool steel	2	ø8: Nickel plated
			1	ø12 to ø40: Nickel plated
18	**Magnet**	—	1	
19	**Plug**	Alloyed steel	3	Nickel plated
20	**Hexagon socket head set screw**	Alloyed steel	1	Black zinc chromated
21	**Piston seal**	NBR	1	
22	**Spline seal**	NBR	1	Rod seal for ø8
23	**Collar gasket**	NBR	1	
24	**Tube gasket**	NBR	1	ø8
			2	ø12 to ø40
25	**Piston gasket**	NBR	1	
26	**Cushion seal**	Urethane	2	
27	**Needle gasket**	NBR	2	
28	**Piston seal for lock**	NBR	1	
29	**Cap gasket**	NBR	1	

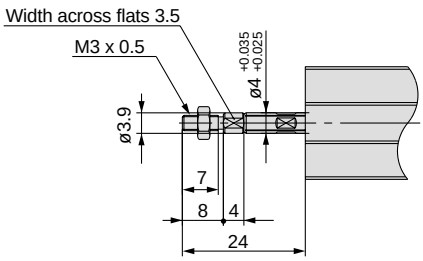
Dimensions/Ø8

MTS8

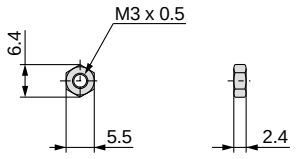
Basic type



Rod end male threads



Stud bolt part number: MT-S8

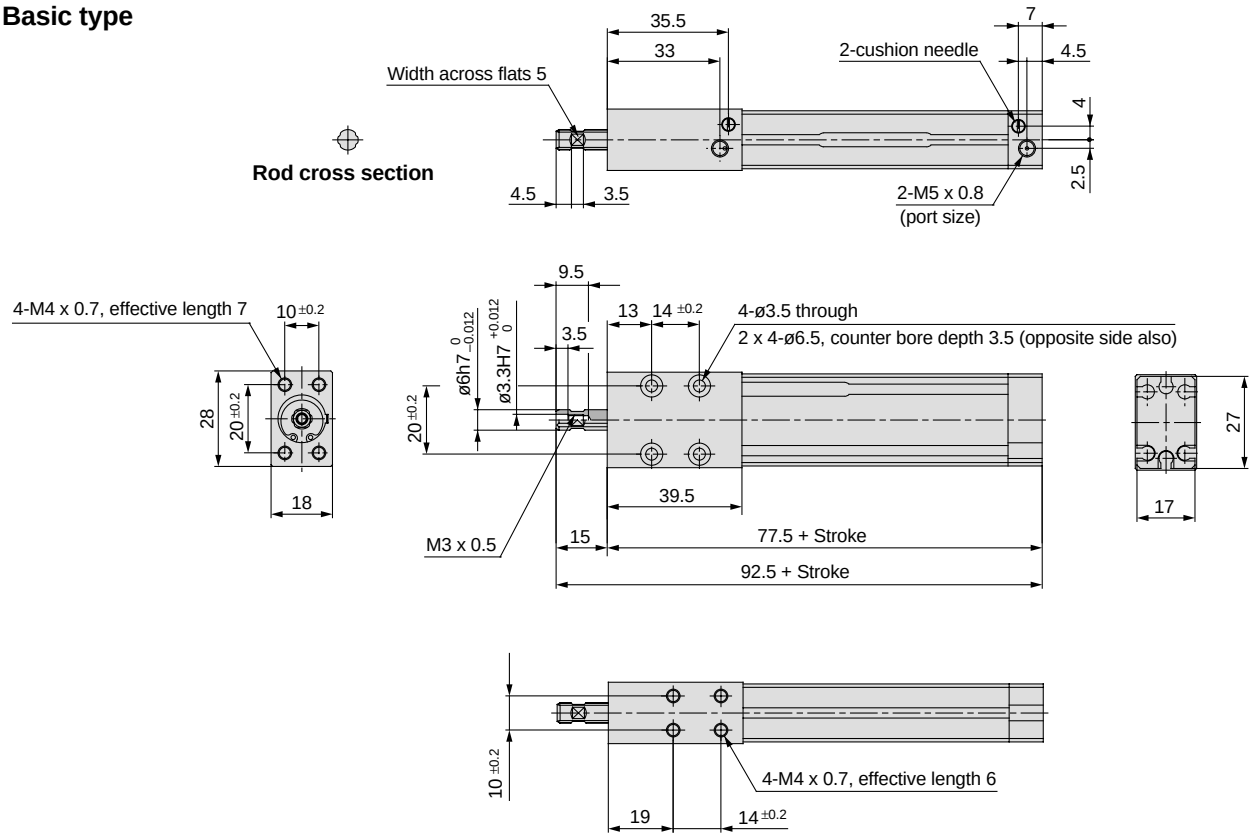


Rod end nut part number: NTJ-006A

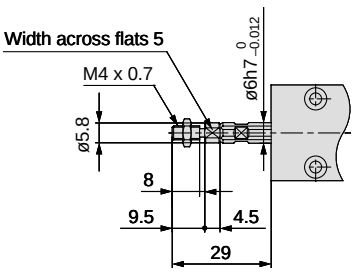
Dimensions/Ø12

MTS12

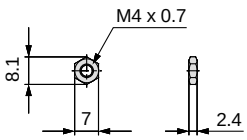
Basic type



Rod end male threads

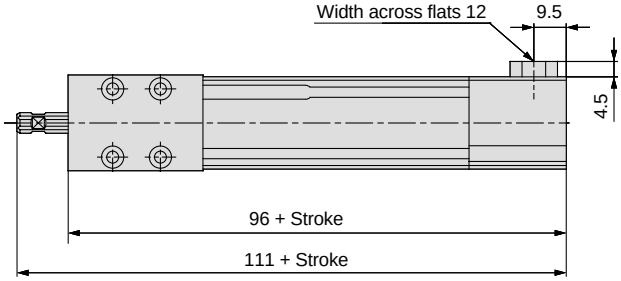


Stud bolt part number: **MT-S12**



Rod end nut part number: NTP-010

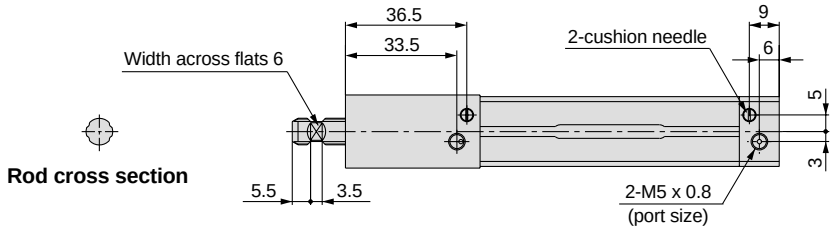
With end lock

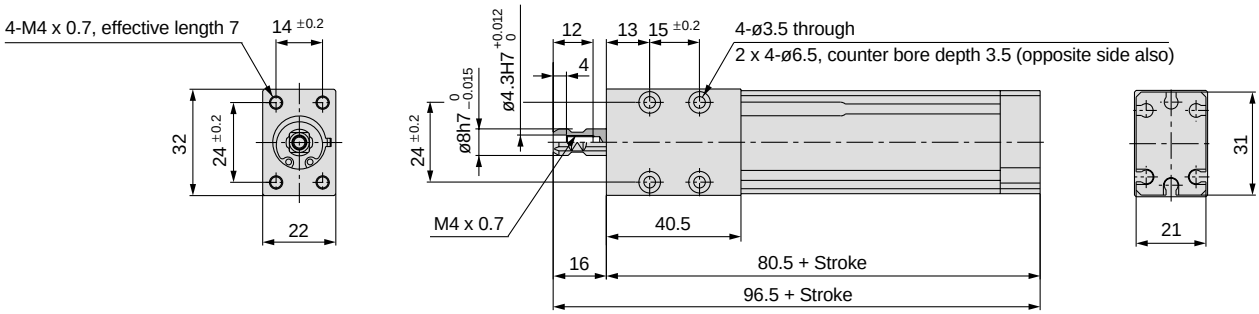


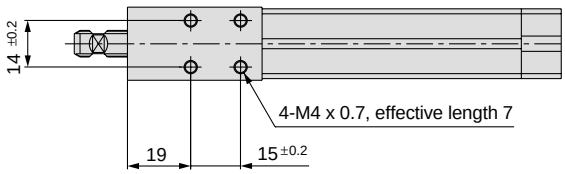
Dimensions/Ø16

MTS16

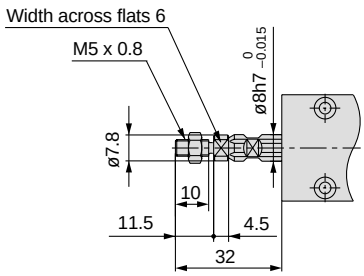
Basic type



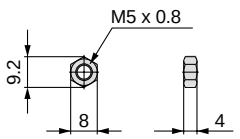




Rod end male threads

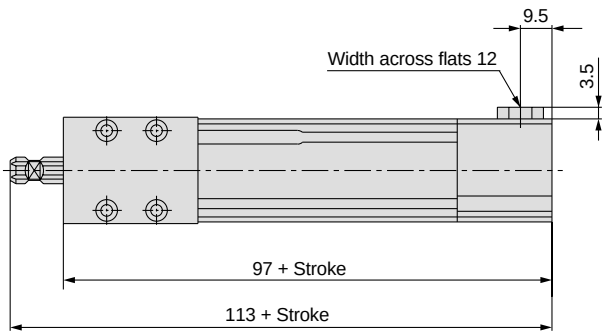


Stud bolt part number: MT-S16



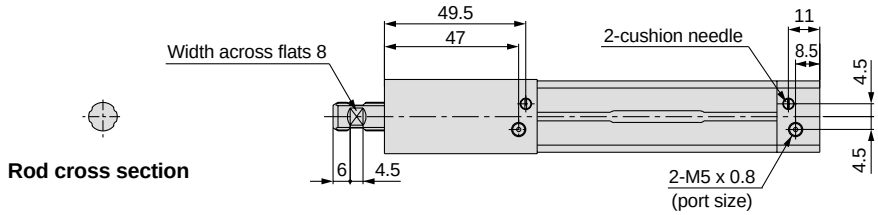
Rod end nut part number: NTJ-015A

With end lock

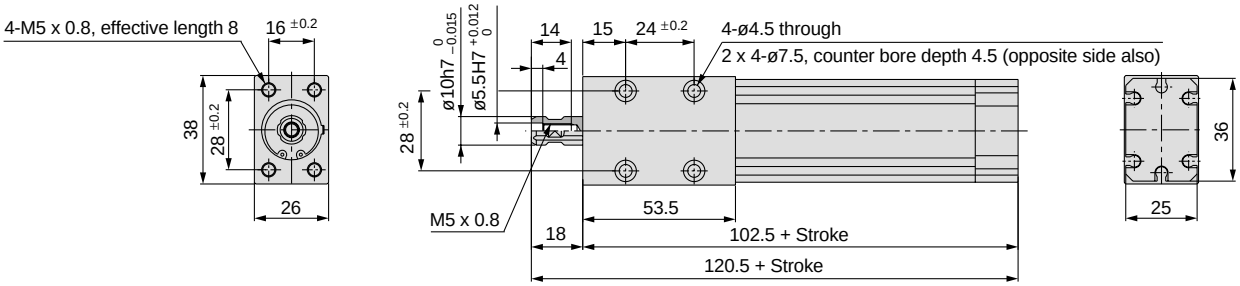


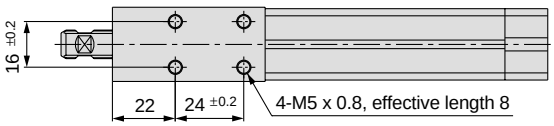
MTS20

Basic type

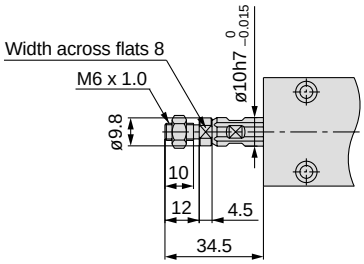


Rod cross section

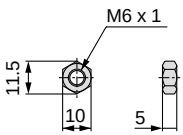




Rod end male threads

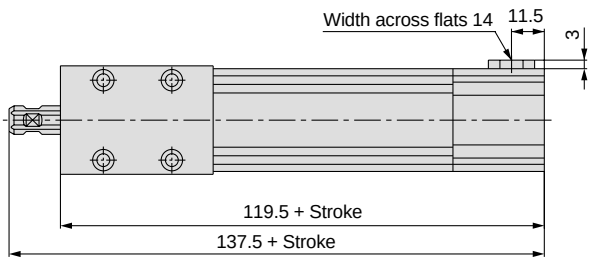


Stud bolt part number: MT-S20



Rod end nut part number: NT-015A

With end lock

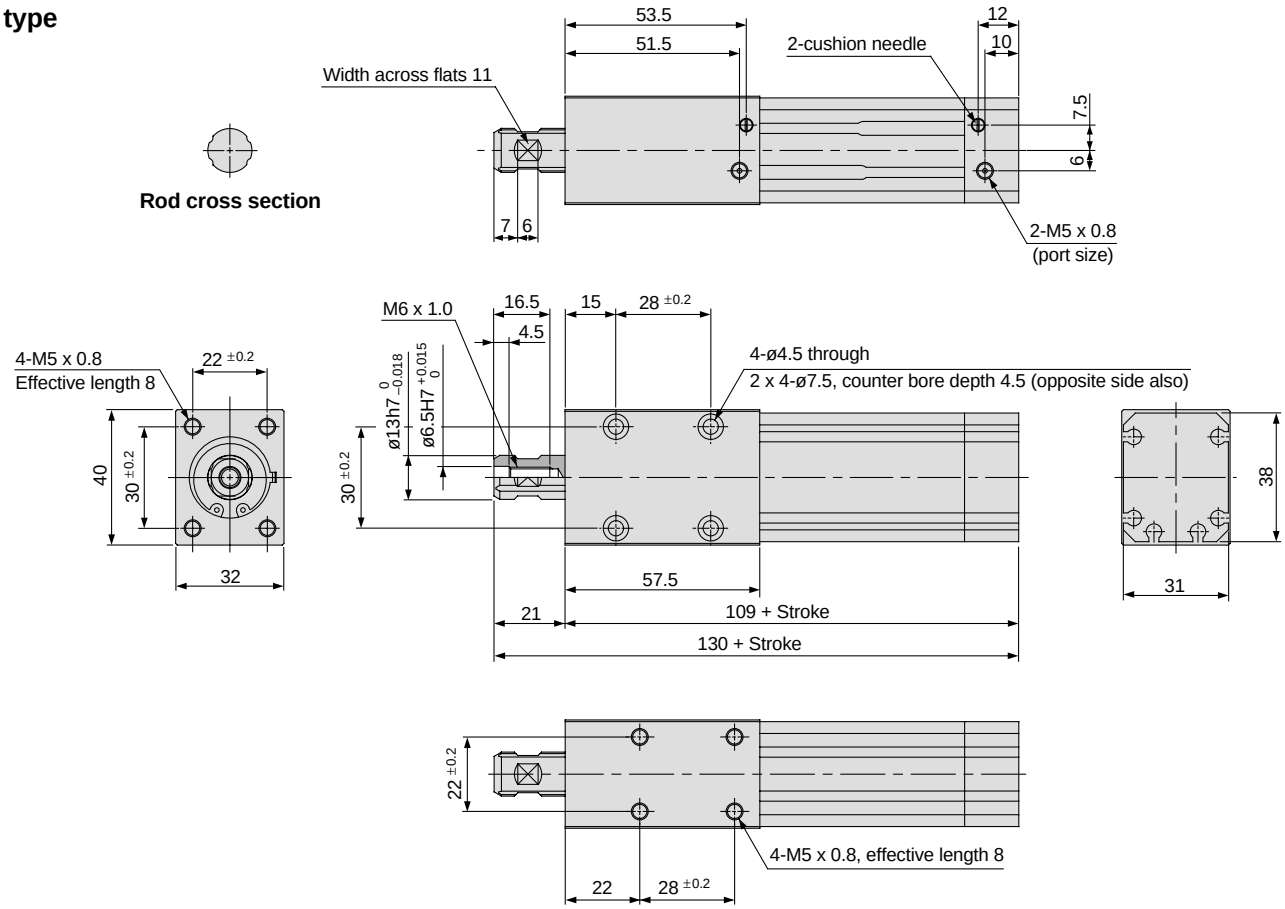


Basic type ..... SMTS20, #1 (#1 + #2)
With end lock ..... SMTS20, #2 (#2 + #4)
Accessories ..... SMTS20, #3

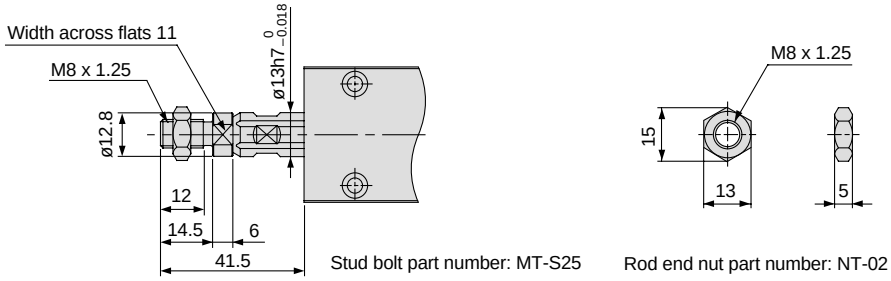
Dimensions/Ø25

MTS25

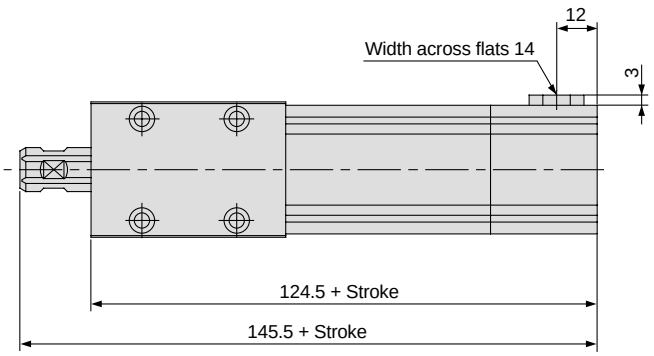
Basic type



Rod end male threads



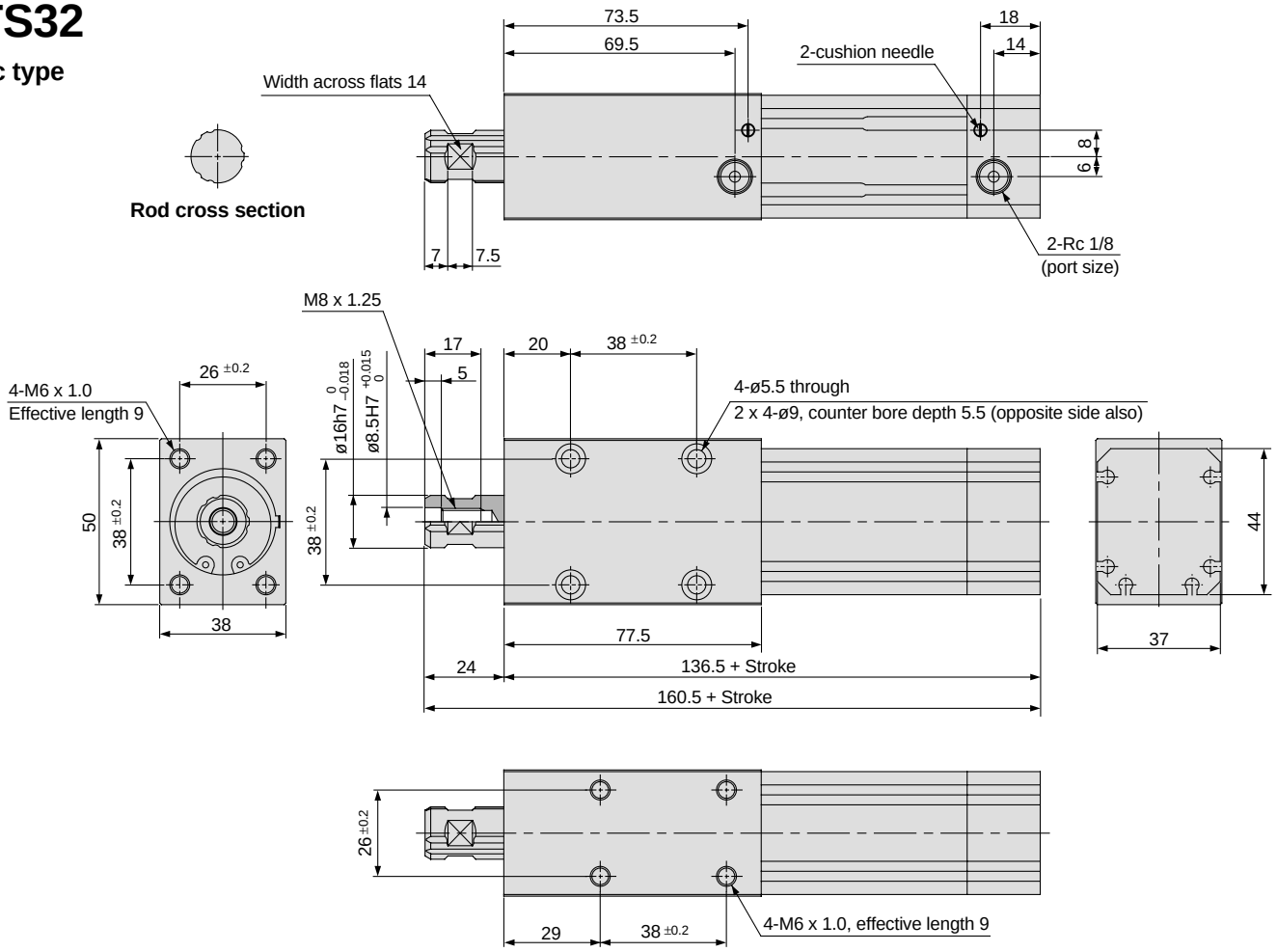
With end lock



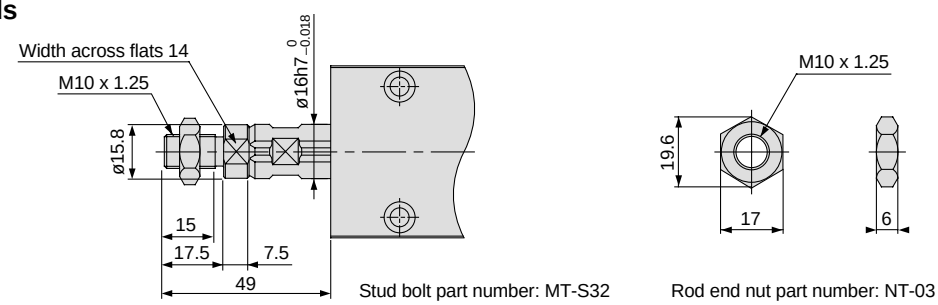
Basic type ..... SMTS25, #1 (#1 + #2)
With end lock ..... SMTS25, #2 (#2 + #4)
Accessories ..... SMTS25, #3

MTS32

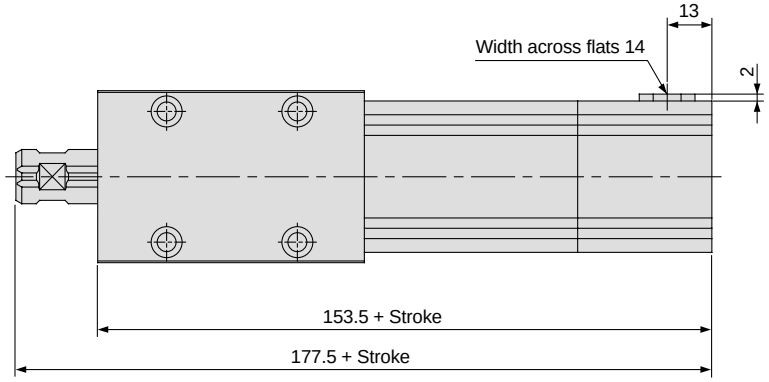
Basic type



Rod end male threads



With end lock

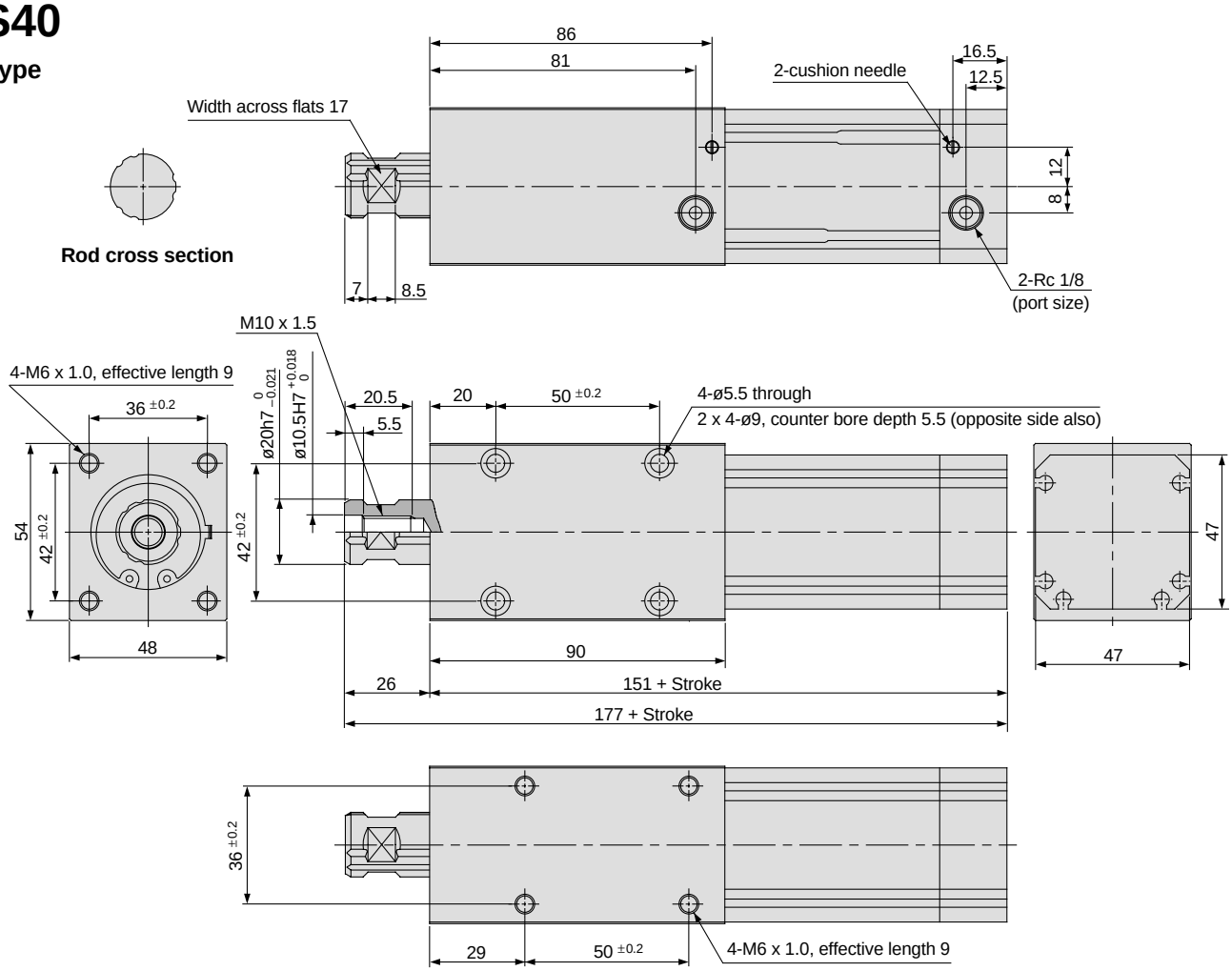


Basic type ..... SMTS32, #1 (#1 + #4)
With end lock ..... SMTS32, #2 (#2 + #4)
Accessories ..... SMTS32, #3

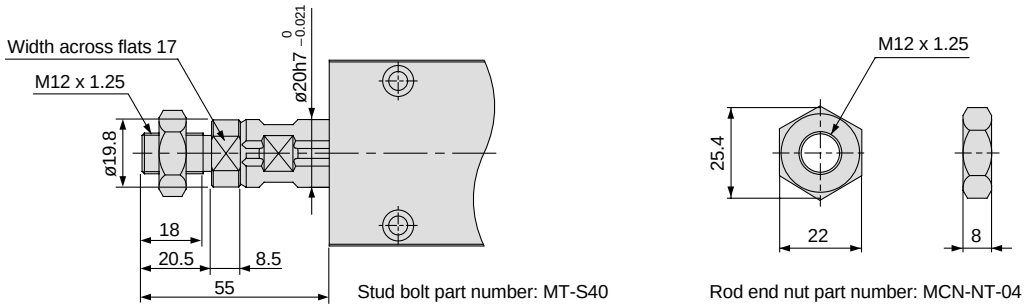
Dimensions/Ø40

MTS40

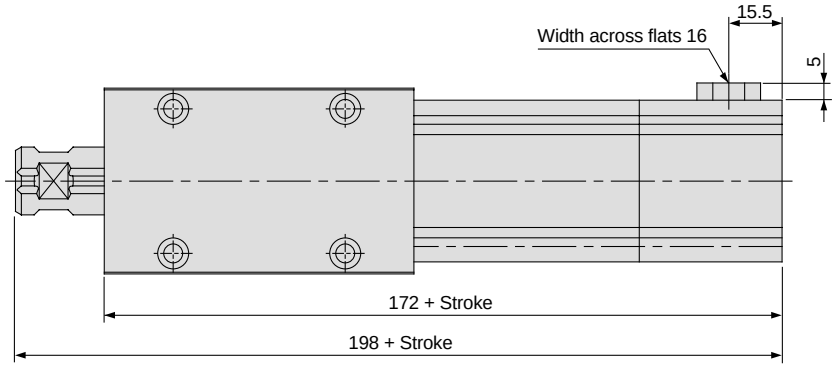
Basic type



Rod end male threads



With end lock

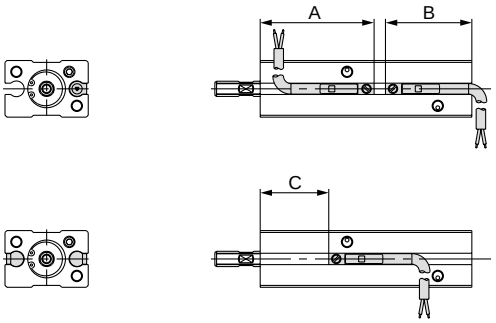


Basic type ····· SMTS40, #1 (#1 + #4)
With end lock ····· SMTS40, #2 (#2 + #4)
Accessories ····· SMTS40, #3

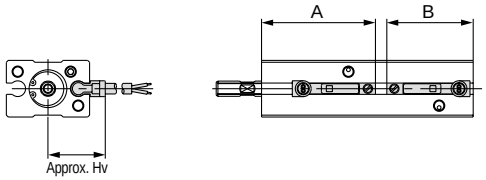
Proper Auto Switch Mounting Positions for Stroke End Detection

ø8

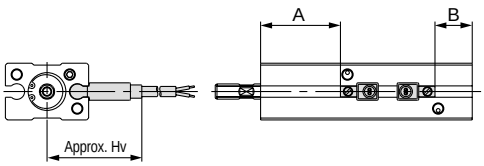
Reed switch: D-A90/A93/A96
Solid state switch: D-F9N/F9P/F9B
2 color indication solid state switch: D-F9NW/F9PW/F9BW



Reed switch: D-A90V/A93V/A96V
Solid state switch: D-F9NV/F9PV/F9BV
2 color indication solid state switch: D-F9NWV/F9PWV/F9BWV



Solid state switch: D-F8N/F8P/F8B

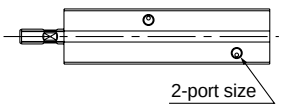
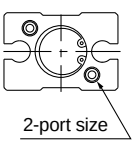


Proper auto switch mounting positions

(mm)

Bore size (mm)	Reed switch						Solid state switch									2 color indication solid state switch					
	D-A90/A93/A96			D-A90V/A93V/A96V			D-F9N/F9P/F9B			D-F9NV/F9PV/F9BV			D-F8N/F8P/F8B			D-F9NW/F9PW/F9BW			D-F9NWV/F9PWV/F9BWV		
	A	B	C	A	B	Hv	A	B	C	A	B	Hv	A	B	Hv	A	B	C	A	B	Hv
8	36	25	16	36	25	15	32	21	20	32	21	17.5	18	7	25	32	21	20	32	21	17.5

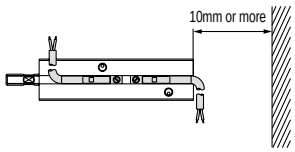
Auto Switch Mounting Strokes for ø8

Piping direction	Mounting condition	Applicable auto switch	Stroke (mm)						Note
			5	10	15	20	25	30	
Standard piping type Note 1) 	2 pcs. on same side 	**D-A9□**	X	X	X	○	○	○	Note 2)
		D-F9□, D-F9□W	X	X	○	○	○	○	Note 2)
		D-A9□V	X	X	X	○	○	○	
	1 pc. each on 2 sides 	**D-A9□**	X	○	○	○	○	○	Note 2)
		D-F9□, D-F9□W	○	○	○	○	○	○	Note 2)
		D-A9□V	X	○	○	○	○	○	
Axial piping type 	2 pcs. on same side 	**D-A9□**	X	X	X	○	○	○	Note 2)
		D-F9□, D-F9□W	X	X	○	○	○	○	Note 2)
		D-A9□V	X	X	X	○	○	○	
		D-F9□V, D-F9□WV	X	X	○	○	○	○	
		D-F8□	○	○	○	○	○	○	
	1 pc. each on 2 sides 	**D-A9□**	X	○	○	○	○	○	Note 2)
		D-F9□, D-F9□W	○	○	○	○	○	○	Note 2)
		D-A9□V	X	○	○	○	○	○	
		D-F9□V, D-F9□WV	○	○	○	○	○	○	
		D-F8□	○	○	○	○	○	○	

Note 1) With the standard piping type, solid state switches D-F8□, D-F9□V, and D-F9□WV with perpendicular electrical entry cannot be mounted due to the interference of the fitting and speed controller.

○ ... Mountable
X .... Not mountable

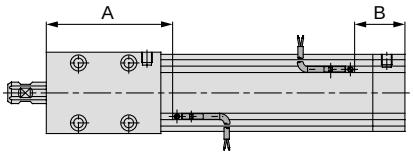
Note 2) When mounting auto switches with in-line electrical entry, allow a space of 10mm or more at the rear end to prevent lead wire interference.



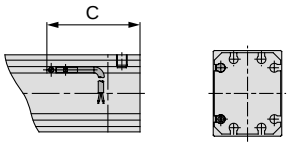
Proper Auto Switch Mounting Positions for Stroke End Detection

ø12 to ø40

Reed switch: D-A90/A93/A96
Solid state switch: D-F9N/F9P/F9B

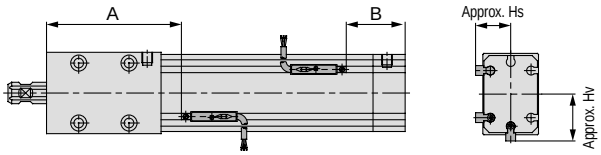


For ø12, 16, 20

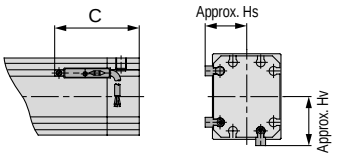


For ø25, 32, 40

2 color indication solid state switch: D-F9NW/F9PW/F9BW

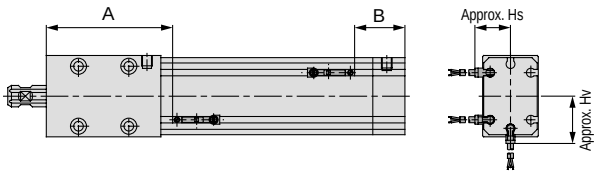


For ø12, 16, 20

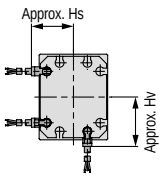


For ø25, 32, 40

Reed switch: D-A90V/A93V/A96V
Solid state switch: D-F9NV/F9PV/F9BV

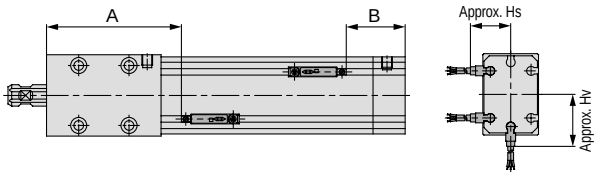


For ø12, 16, 20

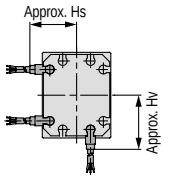


For ø25, 32, 40

2 color indication solid state switch: D-F9NWV/F9PWV/F9BWV



For ø12, 16, 20



For ø25, 32, 40

Proper auto switch mounting positions

(mm)

Bore size (mm)	Reed switch							Solid state switch							2 color indication solid state switch								
	D-A90/A93/A96			D-A90V/A93V/A96V				D-F9N/F9P/F9B			D-F9NV/F9PV/F9BV				D-F9NW/F9PW/F9BW					D-F9NWV/F9PWV/F9BWV			
	A	B	C	A	B	Hs	Hv	A	B	C	A	B	Hs	Hv	A	B	C	Hs	Hv	A	B	Hs	Hv
12	42	15.5	35.5	42	15.5	13	18	46	19.5	31.5	46	19.5	15	20	45	18.5	32.5	12.5	17.5	45	18.5	15	20
16	43.5	17	37	43.5	17	15	20	47.5	21	33	47.5	21	17	22	46.5	20	34	14.5	19.5	46.5	20	17	22
20	59.5	23	43	59.5	23	17	22.5	63.5	27	39	63.5	27	19	24.5	62.5	26	40	16.5	22	62.5	26	19	24.5
25	63	26	46	63	26	20	23.5	67	30	42	67	30	22	25.5	66	29	43	19.5	23	66	29	22	25.5
32	84.5	32	52	84.5	32	23	26.5	88.5	36	48	88.5	36	25	28.5	87.5	35	49	22.5	26	87.5	35	25	28.5
40	98.5	32.5	52.5	98.5	32.5	28	28	102.5	36.5	48.5	102.5	36.5	30	30	101.5	35.5	49.5	27.5	27.5	101.5	35.5	30	30

Auto Switch Mounting

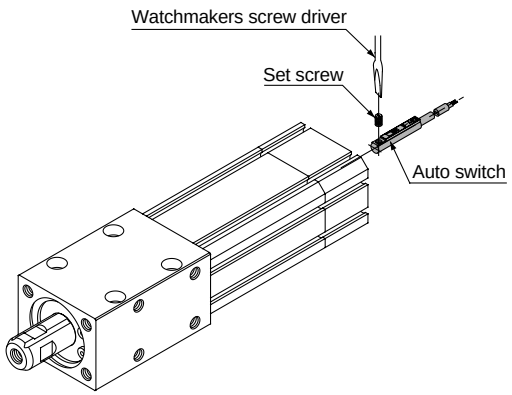
⚠Caution

Auto switch mounting tools

When tightening the set screw (included with auto switches), use a watchmakers screw driver with a handle about 5 to 6mm in diameter.

Tightening torque

Tighten with a torque of 0.10 to 0.20 N·m.



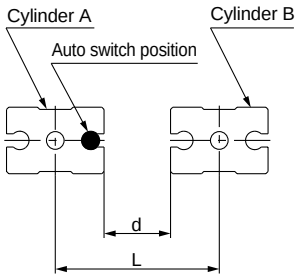
Using Cylinders in Close Proximity to One Another

⚠Caution

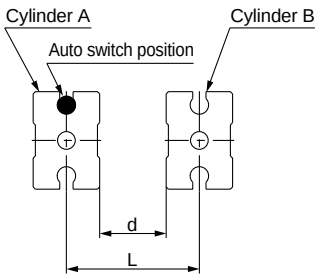
1. When cylinders are used in close proximity to one another as in mounting patterns 1 through 4, the magnetic force of the auto switch magnets in cylinder B may have an effect on the operation of the auto switches on cylinder A. The mounting pitch of cylinders should be at least the values given in the table below.

ø8

Mounting type 1



Mounting type 2



Dimensions by mounting type

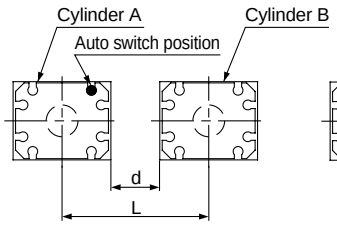
(mm)

Bore size (mm)	Auto switch model	1		2	
		L	d	L	d
8	D-A9□, D-A9□V	25 (37)	3 (15)	15	0
	D-F9□, D-F9□V	25 (39)	3 (17)	15	0
	D-F8□	47	25	15	0
	D-F9□W, D-F9□WV	25 (39)	3 (17)	15	0

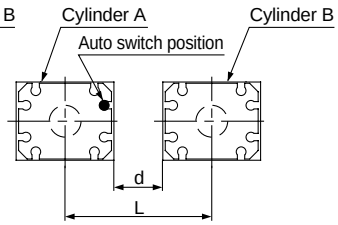
Values inside ( ) are for models D-A9□V, D-F9□V and D-F9□WV.

ø12 to ø40

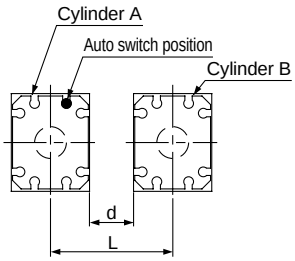
Mounting type 1



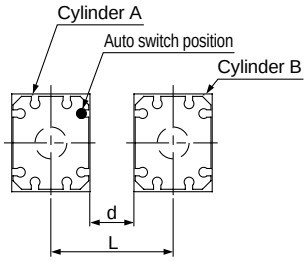
Mounting type 2



Mounting type 3



Mounting type 4



Dimensions by mounting type

(mm)

Bore size (mm)	Auto switch model	1		2		3		4	
		L	d	L	d	L	d	L	d
12	D-A9□, D-A9□V	28	0	28 (43)	0 (15)	18	0	18 (33)	0 (15)
	D-F9□, D-F9□V	28	0	33 (45)	5 (17)	18	0	28 (35)	10 (17)
	D-F9□W, D-F9□WV	28	0	33 (45)	5 (17)	18	0	28 (35)	10 (17)
16	D-A9□, D-A9□V	32	0	32 (47)	0 (15)	22	0	22 (37)	0 (15)
	D-F9□, D-F9□V	32	0	37 (49)	5 (17)	22	0	32 (39)	10 (17)
	D-F9□W, D-F9□WV	32	0	37 (49)	5 (17)	22	0	32 (39)	10 (17)
20	D-A9□, D-A9□V	38	0	38 (53)	0 (15)	26	0	26 (41)	0 (15)
	D-F9□, D-F9□V	38	0	38 (55)	0 (17)	26	0	31 (43)	5 (17)
	D-F9□W, D-F9□WV	38	0	38 (55)	0 (17)	26	0	36 (43)	10 (17)
25	D-A9□, D-A9□V	40	0	40 (55)	0 (15)	32	0	32 (47)	0 (15)
	D-F9□, D-F9□V	40	0	50 (57)	10 (17)	32	0	42 (49)	10 (17)
	D-F9□W, D-F9□WV	40	0	50 (57)	10 (17)	32	0	47 (49)	15 (17)
32	D-A9□, D-A9□V	50	0	50 (62)	0 (12)	38	0	38 (53)	0 (15)
	D-F9□, D-F9□V	50	0	55 (64)	5 (14)	38	0	48 (55)	10 (17)
	D-F9□W, D-F9□WV	50	0	55 (64)	5 (14)	38	0	48 (55)	10 (17)
40	D-A9□, D-A9□V	54	0	54 (66)	0 (12)	48	0	48 (63)	0 (15)
	D-F9□, D-F9□V	54	0	59 (68)	5 (14)	48	0	58 (65)	10 (17)
	D-F9□W, D-F9□WV	54	0	59 (68)	5 (14)	48	0	58 (65)	10 (17)

Values inside ( ) are for models D-A9□V, D-F9□V and D-F9□WV.
If cylinders are used with a mounting pitch less than shown above, they must be shielded with iron plates or the separately sold magnetic shielding plate (part no. MU-S025). Contact SMC for further information.

2. Avoid wiring patterns in which bending stress and pulling force are repeatedly applied to the lead wires.

Series MTS
Auto Switch Specifications

Auto Switch Common Specifications

Type	Reed switch	Solid state switch
Leakage current	None	3 wire: 100μA or less, 2 wire: 0.8mA or less
Operating time	1.2ms	1ms or less
Impact resistance	300m/s²	1000m/s²
Insulation resistance	50MΩ or more at 500VDC (between lead wire and case)	
Withstand voltage	1500VAC for 1 min. (between lead wire and case)	1000VAC for 1 min. (between lead wire and case)
Ambient temperature	–10 to 60°C	
Enclosure	IEC529 standard IP67, JISC0920 watertight construction	

Lead Wire Length

Lead wire length indication

(Example) **D-F9P L**

Lead wire length

Nil	0.5m
L	3m
Z	5m

Note 1) Lead wire length Z: 5m applicable auto switches
Solid state: All types are produced upon receipt of order (standard).

Note 2) Add –61 after the lead wire length for solid state switches with flexible specification.

(Example) **D-F9PL-61**

Flexible specification

Contact Protection Boxes/CD-P11, CD-P12

<Applicable switches>

D-A9/A9□V

The above auto switches do not have internal contact protection circuits.

1. The operating load is an induction load.
2. The length of wiring to the load is 5m or more.
3. The load voltage is 100VAC.

Use a contact protection box in any of the above situations.
The life of the contacts may otherwise be reduced. (They may stay ON all the time.)

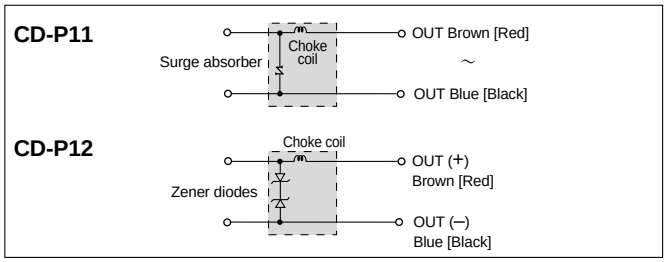
Contact protection box specifications

Part number	CD-P11		CD-P12
Load voltage	100VAC	200VAC	24VDC
Maximum load current	25mA	12.5mA	50mA

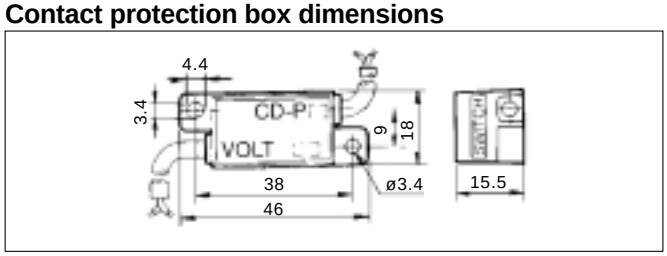
∗ Lead wire length —— Switch connection side 0.5m
Load connection side 0.5m

Contact protection box internal circuits

Lead wire colors inside [ ] are those prior to conformity with IEC standards.



Contact protection box dimensions



Contact Protection Box Connection

To connect a switch to a contact protection box, connect the lead wire from the side of the contact protection box marked SWITCH to the lead wire coming out of the switch. Furthermore, the switch unit should be kept as close as possible to the contact protection box, with a lead wire length of no more than 1 meter between them.

Solid State Switches/Direct Mount Type
D-F8N/D-F8P/D-F8B

Auto Switch Specifications

Auto switch part no.	D-F8N	D-F8P	D-F8B
Electrical entry direction	Perpendicular		
Wiring type	3 wire		2 wire
Output type	NPN type	PNP type	—
Applicable load	IC circuit, 24VDC relay, PLC		24VDC relay, PLC
Power supply voltage	5, 12, 24VDC (4.5 to 28VDC)		—
Current consumption	10mA or less		—
Load voltage	28VDC or less	—	24VDC (10 to 28VDC)
Load current	40mA or less	80mA or less	2.5 to 40mA
Internal voltage drop	1.5V or less (0.8V or less at a load current of 10mA)	0.8V or less	4V or less
Leakage current	100μA or less at 24VDC		0.8mA or less at 24VDC
Indicator light	Red LED lights up when ON		

● Lead wire — Heavy duty oil resistant vinyl cord, ø2.7, 0.5m
D-F8N, D-F8P 0.15mm² x 3 cores (Brown, Black, Blue [Red, White, Black])
D-F8B 0.18mm² x 2 cores (Brown, Blue [Red, Black])

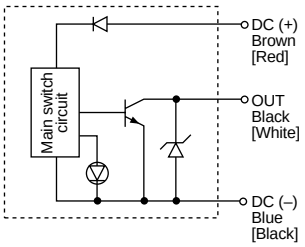
Note 1) Refer to page 14 for auto switch common specifications.

Note 2) Refer to page 14 for lead wire length.

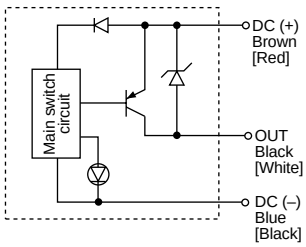
Auto switch internal circuits

Lead wire colors inside [ ] are those prior to conformity with IEC standards.

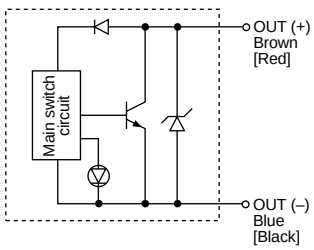
D-F8N



D-F8P



D-F8B



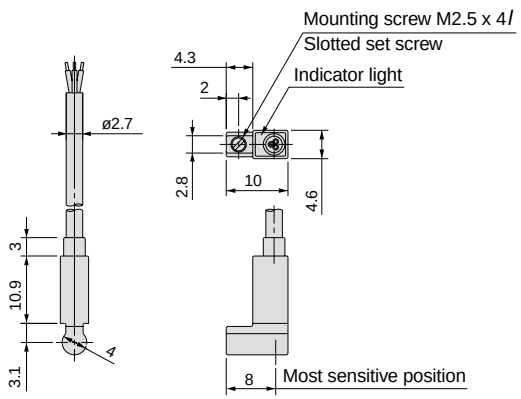
Auto Switch Weights

Unit: g

Model	D-F8N	D-F8P	D-F8B
Lead wire length 0.5m	7		
Lead wire length 3m	32		

Auto Switch Dimensions

D-F8N, D-F8P, D-F8B



SMC

Solid State Switches/Direct Mount Type
D-F9N(V)/D-F9P(V)/D-F9B(V)

Grommet

Auto Switch Specifications

D-F9□, D-F9□V (with indicator light)						
Auto switch part no.	D-F9N	D-F9NV	D-F9P	D-F9PV	D-F9B	D-F9BV
Electrical entry direction	In-line	Perpendicular	In-line	Perpendicular	In-line	Perpendicular
Wiring type	3 wire				2 wire	
Output type	NPN		PNP		—	
Applicable load	IC circuit, Relay, PLC				24VDC relay, PLC	
Power supply voltage	5, 12, 24VDC (4.5 to 28V)				—	
Current consumption	10mA or less				—	
Load voltage	28VDC or less		—		24VDC (10 to 28VDC)	
Load current	40mA or less		80mA or less		5 to 40mA	
Internal voltage drop	1.5V or less (0.8V or less at a load current of 10mA)		0.8V or less		4V or less	
Leakage current	100μA or less at 24VDC				0.8mA or less	
Indicator light	Red LED lights when ON					

- Lead wire — Oil resistant heavy duty vinyl cord, ø2.7
  3 cores (Brown, Black, Blue [Red, White, Black]), 0.15mm²
  2 cores (Brown, Blue [Red, Black]), 0.18mm², 0.5m

Note 1) Refer to page 14 for solid state switch common specifications.

Note 2) Refer to page 14 for lead wire length.

Auto Switch Weights

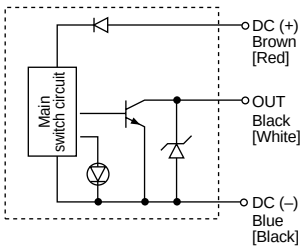
Unit: g

Model	D-F9N	D-F9P	D-F9B	D-F9NV	D-F9PV	D-F9BV
Lead wire length 0.5m	7	7	6	7	7	6
Lead wire length 3m	37	37	31	37	37	31

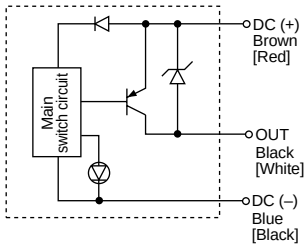
Auto switch internal circuits

Lead wire colors inside [ ] are those prior to conformity with IEC standards.

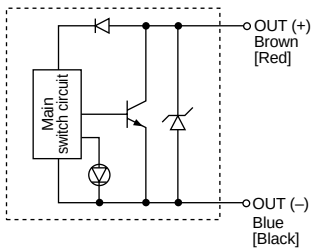
D-F9N(V)



D-F9P(V)

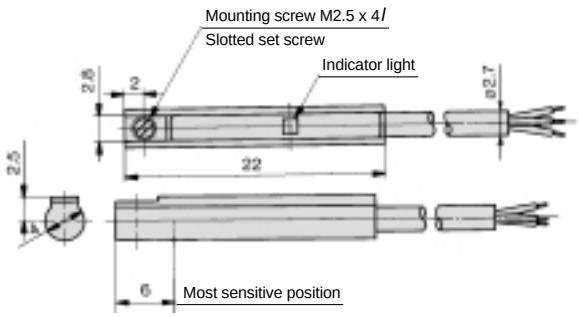


D-F9B(V)

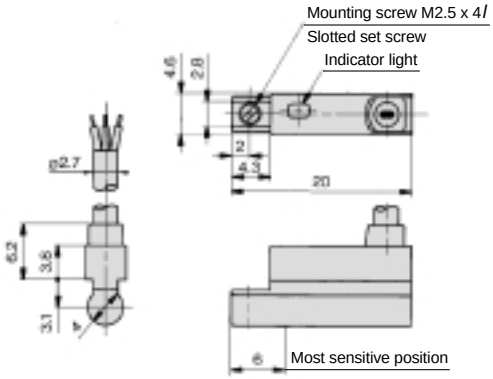


Auto Switch Dimensions

D-F9N, D-F9P, D-F9B



D-F9NV, D-F9PV, D-F9BV



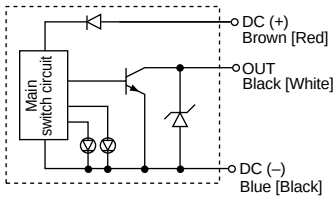
2 Color Indication Solid State Switches Direct Mount Type
D-F9NW(V)/D-F9PW(V)/D-F9BW(V)

Grommet

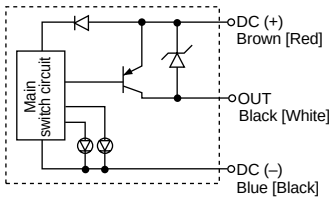
Auto switch internal circuits

Lead wire colors inside [ ] are those prior to conformity with IEC standards.

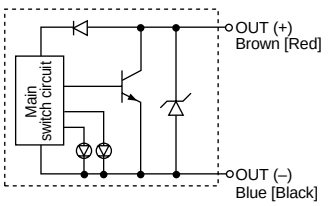
D-F9NW(V)



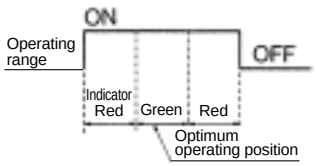
D-F9PW(V)



D-F9BW(V)



Indicator light/Display method



Auto Switch Specifications

D-F9□W, D-F9□WV (with indicator light)						
Auto switch part no.	D-F9NW	D-F9NWV	D-F9PW	D-F9PWV	D-F9BW	D-F9BWV
Electrical entry direction	In-line	Perpendicular	In-line	Perpendicular	In-line	Perpendicular
Wiring type	3 wire				2 wire	
Output type	NPN		PNP		—	
Applicable load	IC circuit, Relay, PLC				24VDC relay, PLC	
Power supply voltage	5, 12, 24VDC (4.5 to 28V)				—	
Current consumption	10mA or less				—	
Load voltage	28VDC or less		—		24VDC (10 to 28VDC)	
Load current	40mA or less		80mA or less		5 to 40mA	
Internal voltage drop	1.5V or less (0.8V or less at a load current of 10mA)		0.8V or less		4V or less	
Leakage current	100μA or less at 24VDC				0.8mA or less	
Indicator light	Actuated position …….. Red LED lights up Optimum operating position … Green LED lights up					

- Lead wire — Oil resistant heavy duty vinyl cord, ø2.7
  3 cores (Brown, Black, Blue [Red, White, Black]), 0.15mm²,
  2 cores (Brown, Blue [Red, Black]), 0.18mm², 0.5m

Note 1) Refer to page 14 for solid state switch common specifications.

Note 2) Refer to page 14 for lead wire length.

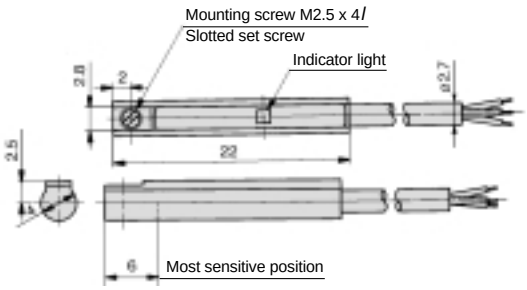
Auto Switch Weights

Unit: g

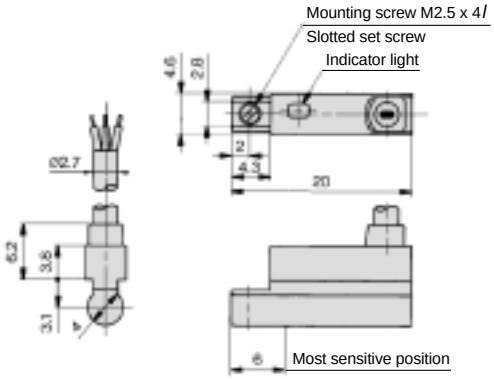
Model	D-F9NW	D-F9NWV	D-F9PW	D-F9PWV	D-F9BW	D-F9BWV
Lead wire length 0.5m	7	7	7	7	7	7
Lead wire length 3m	34	34	34	34	32	32

Auto Switch Dimensions

D-F9NW, D-F9PW, D-F9BW



D-F9NWV, D-F9PWV, D-F9BWV



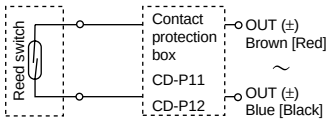
SMC

Reed Switches/Direct Mount Type
D-A90(V)/D-A93(V)/D-A96(V)

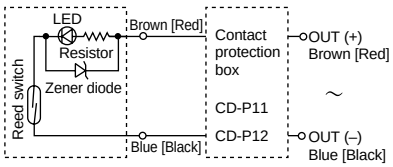
Auto switch internal circuits

Lead wire colors inside [ ] are those prior to conformity with IEC standards.

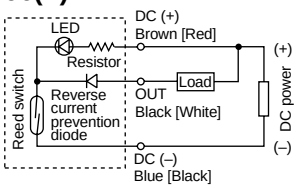
D-A90(V)



D-A93(V)



D-A96(V)



Auto Switch Specifications

Auto switch part no.	D-A90	D-A90V	D-A93	D-A93V	D-A96	D-A96V
Electrical entry direction	In-line	Perpendicular	In-line	Perpendicular	In-line	Perpendicular
Wiring type	2 wire				3 wire	
Applicable load	IC circuit, Relay, PLC		Relay, PLC		IC circuit	
Load voltage / Load current range and Max. load current	24V AC/DC or less/50mA 48V AC/DC or less/40mA 100V AC/DC or less/20mA		24VDC/5 to 40mA 100VAC/5 to 20mA		4 to 8VDC/20mA	
Contact protection circuit	None					
Internal resistance Internal voltage drop	1Ω or less (includes lead wire length 3m)		2.4V or less (–20mA) 3V or less (–40mA)	2.7V or less	0.8V or less	
Indicator light	None		Red LED lights when ON			

- Lead wire — Oil resistant heavy duty vinyl cord, ø2.7
  3 cores (Brown, Black, Blue [Red, White, Black]), 0.15mm²
  2 cores (Brown, Blue [Red, Black]), 0.18mm², 0.5m

Note 1) Refer to page 14 for reed switch common specifications.

Note 2) Refer to page 14 for lead wire length.

Auto Switch Weights

Unit: g

Type	D-A90	D-A90V	D-A93	D-A93V	D-A96	D-A96V
Lead wire length 0.5m	7	7	6	7	8	8
Lead wire length 3m	35	35	30	35	41	41

Contact Protection Boxes

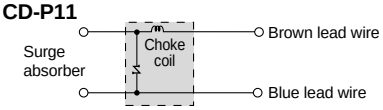
Type D-A9 switches do not have internal contact protection circuits. Use a contact protection box with an induction load, when lead wires are 5 meters or longer, and with 100VAC.

Part no.	Voltage	Lead wire length
CD-P11	100VAC	Switch connection side 0.5m Load connection side 0.5m
CD-P12	24VDC	

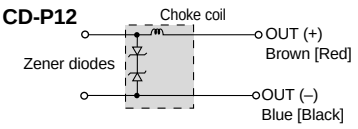
Since D-A90(V) switches have no particular specified voltage below 100VAC, select a model based on the voltage being used.

Contact protection box internal circuits

CD-P11

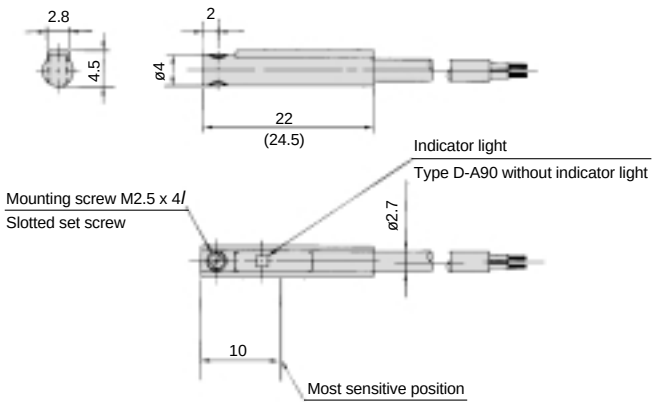


CD-P12

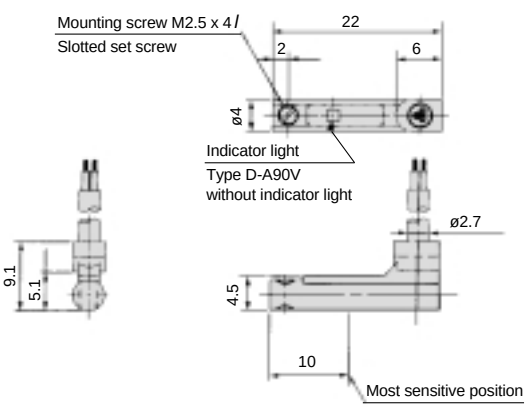


Auto Switch Dimensions

D-A90, D-A93, D-A96



D-A90V, D-A93V, D-A96V

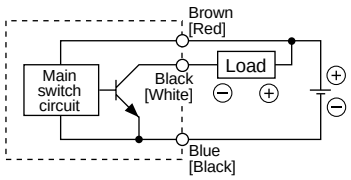


Type D-A93 dimensions are shown inside ( ).

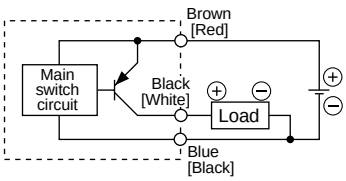
Series MTS
Auto Switch Connections and Examples

Basic Wiring

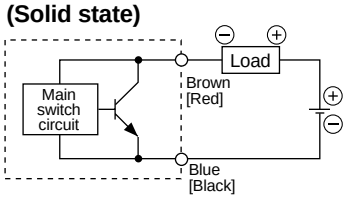
Solid state 3 wire, NPN



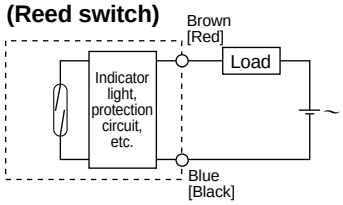
Solid state 3 wire, PNP



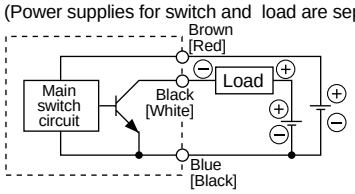
2 wire (Solid state)

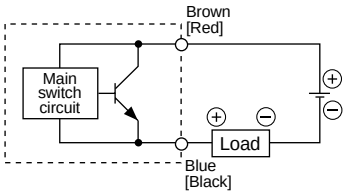


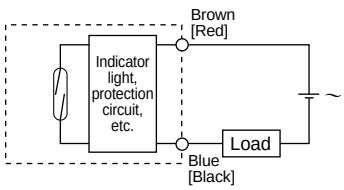
2 wire (Reed switch)



(Power supplies for switch and load are separate.)



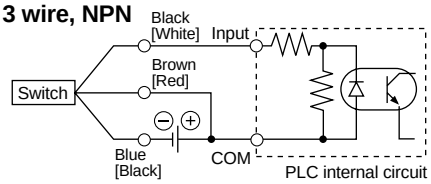




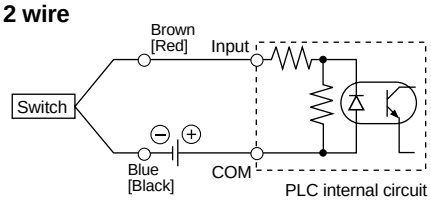
Examples of Connection to PLC

Sink input specifications

3 wire, NPN

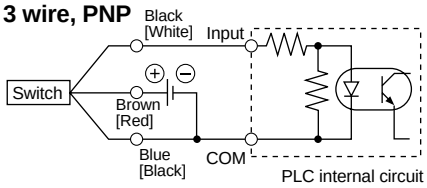


2 wire

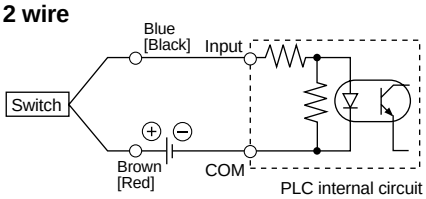


Source input specifications

3 wire, PNP



2 wire

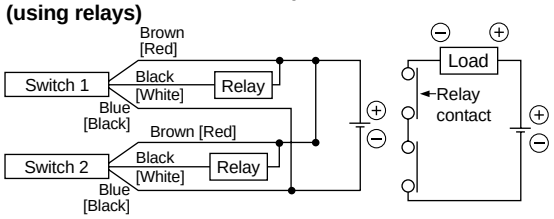


Connect according to the applicable PLC input specifications, as the connection method will vary depending on the PLC input specifications.

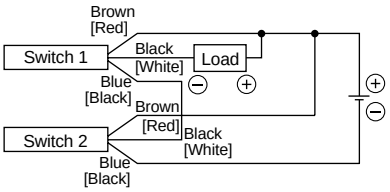
Connection Examples for AND (Series) and OR (Parallel)

3 wire

AND connection for NPN output (using relays)

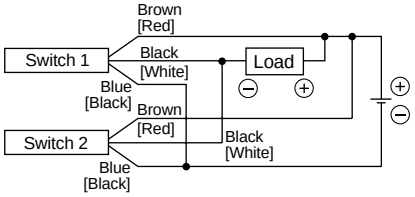


AND connection for NPN output (performed with switches only)

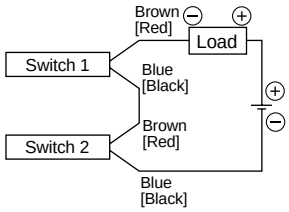


The indicator lights will light up when both switches are turned ON.

OR connection for NPN output



2 wire with 2 switch AND connection



When two switches are connected in series, a load may malfunction because the load voltage will decline when in the ON state. The indicator lights will light up if both of the switches are in the ON state.

Load voltage at ON = $\frac{\text{Power supply voltage}}{} - \frac{\text{Internal voltage drop}}{}$ x 2 pcs.

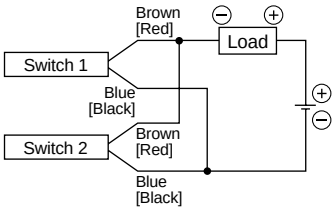
= 24V – 4V x 2 pcs.

= 16V

Example: Power supply is 24VDC

Internal voltage drop in switch is 4V

2 wire with 2 switch OR connection



(Solid state)
When two switches are connected in parallel, malfunction may occur because the load voltage will increase when in the OFF state.

(Reed switch)
Because there is no current leakage, the load voltage will not increase when turned OFF. However, depending on the number of switches in the ON state, the indicator lights may sometimes dim or not light up, because of dispersion and reduction of the current flowing to the switches.

Load voltage at OFF = $\frac{\text{Leakage current}}{}$ x 2 pcs. x $\frac{\text{Load impedance}}{}$

= 1mA x 2 pcs. x 3kΩ

= 6V

Example: Load impedance is 3kΩ

Leakage current from switch is 1mA

SMC

Series MTS
Order Made Specifications

Contact SMC for detailed dimensions, specifications and lead times.

1 Variable Stroke Cylinder/Adjustable Extension Type -XC8

Basic type MTS [Bore size] – [Stroke] – XC8

With end lock (ø12 to ø40) MTS [Bore size] – [Stroke] R – XC8

Stroke adjustment is possible on the rod extension side.
Stroke adjustment range: 0 to 10mm (ø8)
0 to 25mm (ø12 to ø40)

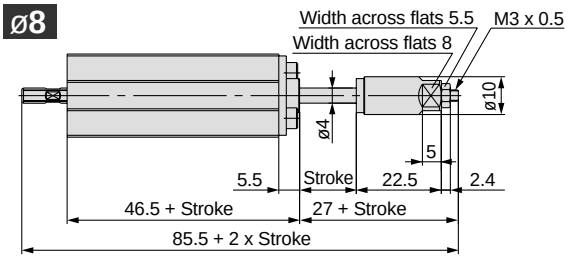
Specifications

Bore size (mm)		8	12	16	20	25	32	40
Minimum operating pressure	Without end lock	0.15MPa	0.12MPa		0.1MPa			
	With end lock *	—	0.17MPa		0.15MPa			
Piping direction		Standard piping type						
Rod end configuration		Female threads, Male threads						
Stroke adjustment method		Stopper adjustment						
Stroke adjustment range		0 to 10mm	0 to 25mm					

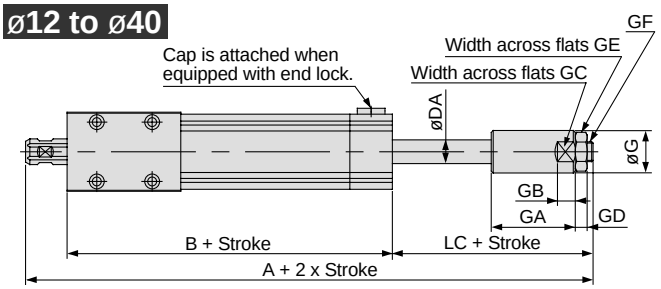
* Except lock unit: 0.12MPa for ø12 and 16
0.10MPa for ø20 to 40

Dimensions

ø8



ø12 to ø40



Basic type (mm)

Bore size (mm)	A	B	LC	DA	G	GA	GB	GC	GD	GE	GF
12	145	80.5	49.5	6	13.5	42.5	6	11	4	8	M5 x 0.8
16	149.5	83	50.5	8	15.5	42.5	7	13	5	10	M6 x 1.0
20	175	106.5	50.5	10	19.5	42.5	8.5	17	5	13	M8 x 1.25
25	187	114.5	51.5	12	21.5	42.5	9	19	6	17	M10 x 1.25
32	222.5	142.5	56	16	27.5	45	10.5	24	8	22	M14 x 1.5
40	240	155	59	20	32.5	45	11.5	27	11	27	M18 x 1.5

With end lock (mm)

Bore size (mm)	A	B
12	163	98.5
16	165.5	99
20	191.5	123
25	201.5	129
32	238.5	158.5
40	258.5	173.5

* Other dimensions are the same as the standard type.

2 Vacuum Specification/Rod Through Hole Type -XC38

MTS8 – [Stroke] (P) – XC38

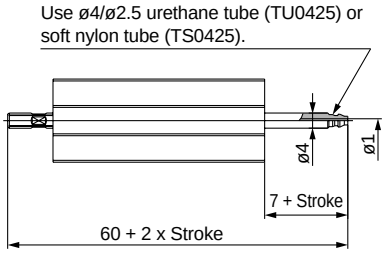
Axial piping type

Vacuum specification
Rod through hole type

Specifications

Bore size (mm)	8
Piping direction	Standard piping type, Axial piping type
Rod end configuration	Female threads

Dimensions

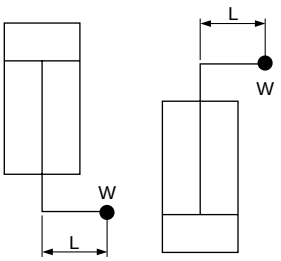


Model Selection

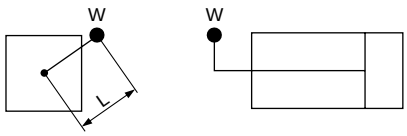
⚠Caution **Theoretical output must be confirmed separately. Refer to the theoretical output table on page 2.**

Selection Conditions: Follow the tables below in order to determine selection conditions and choose one selection graph.

Vertical mounting

Mounting orientation								
Max. speed mm/s		to 100	to 200	to 300	to 400	to 500	to 600	to 800
Stroke mm		All strokes common						
Selection graph	ø8	1	—	2	—	3	—	—
	ø12 to ø40	—	4	—	5	—	6	7

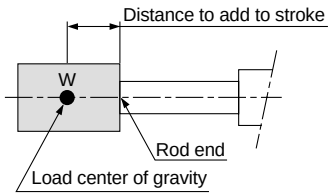
Horizontal mounting

Mounting orientation		 ∗ Direction for L can be up, down, left, right, or diagonal.													
Max. speed mm/s		to 300			to 500			to 600				to 800			
Stroke mm		to 10	to 20	to 30	to 10	to 20	to 30	to 50	to 100	to 150	to 200	to 50	to 100	to 150	to 200
Selection graph	ø8	8	9	10	11	12	13	—	—	—	—	—	—	—	—
	ø12 to ø40	—	—	—	—	—	—	14	15	16	17	18	19	20	21

∗ L: Overhang ..... The distance between the cylinder's central axis and the load center of gravity

⚠Caution

- In case of horizontal mounting, when the load center of gravity is beyond the rod end, add that distance to the stroke to select a graph.



Selection Examples

1. Selection conditions
   - Mounting: Vertical
   - Maximum speed: 800mm/s
   - Overhang: 50mm
   - Load weight: 2kg

Refer to graph 7 based on vertical mounting and the maximum speed of 800mm/s. On graph 7, find the intersecting point for the overhang of 50mm and the load weight of 2kg to determine ø32.

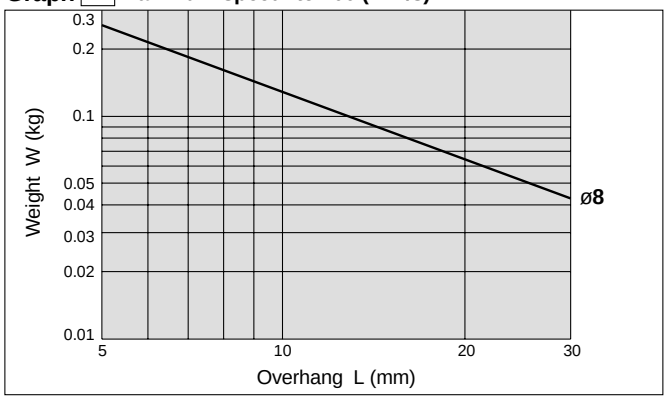
2. Selection conditions
   - Mounting: Horizontal
   - Maximum speed: 600mm/s
   - Stroke: 125mm
   - Overhang: 80mm
   - Load weight: 0.7kg

Refer to graph 16 based on horizontal mounting, the maximum speed of 600mm/s, and 125mm stroke. On graph 16, find the intersecting point for the overhang of 80mm and the load weight of 0.7kg to determine ø25.

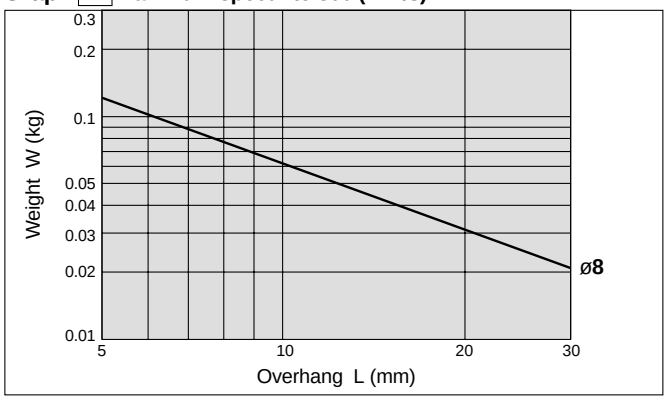
Horizontal Mounting

ø8

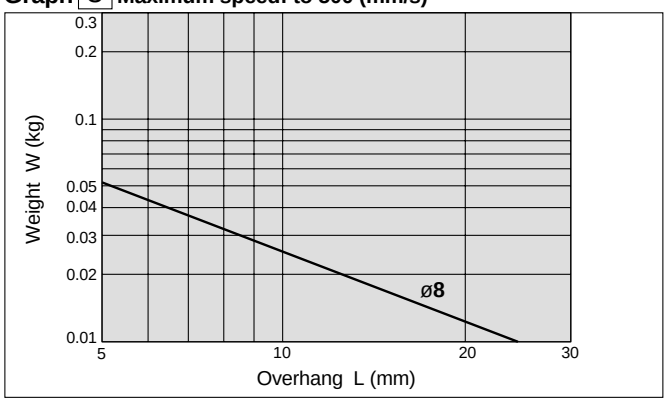
Graph 1 Maximum speed: to 100 (mm/s)



Graph 2 Maximum speed: to 300 (mm/s)

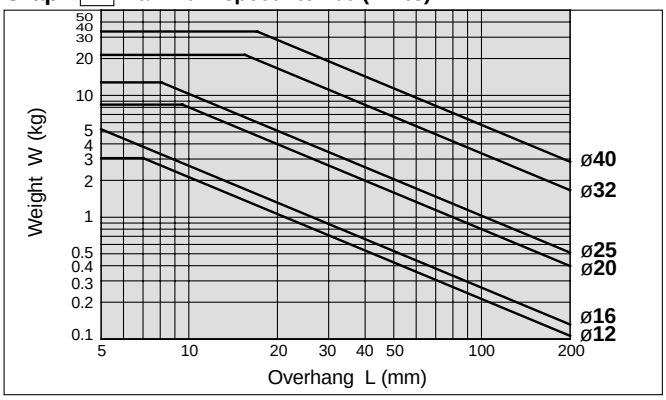


Graph 3 Maximum speed: to 500 (mm/s)

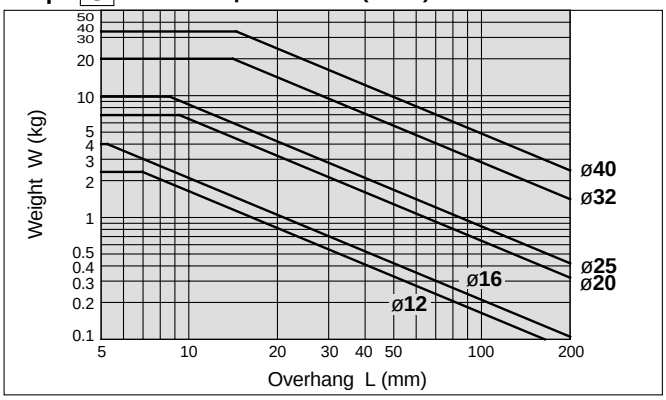


ø12 to ø40

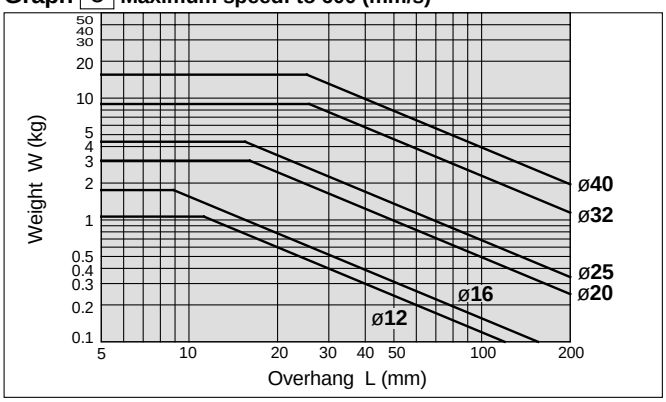
Graph 4 Maximum speed: to 200 (mm/s)



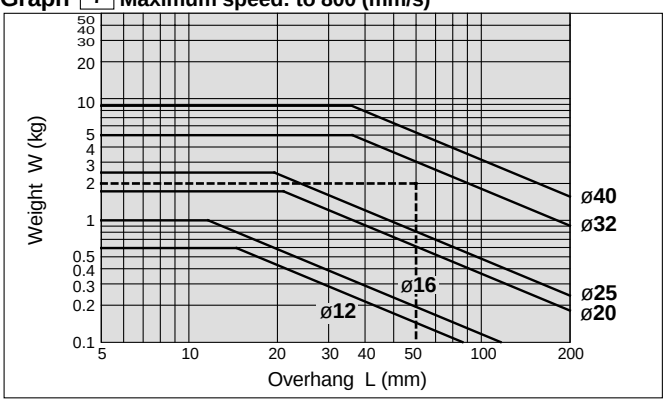
Graph 5 Maximum speed: to 400 (mm/s)



Graph 6 Maximum speed: to 600 (mm/s)



Graph 7 Maximum speed: to 800 (mm/s)

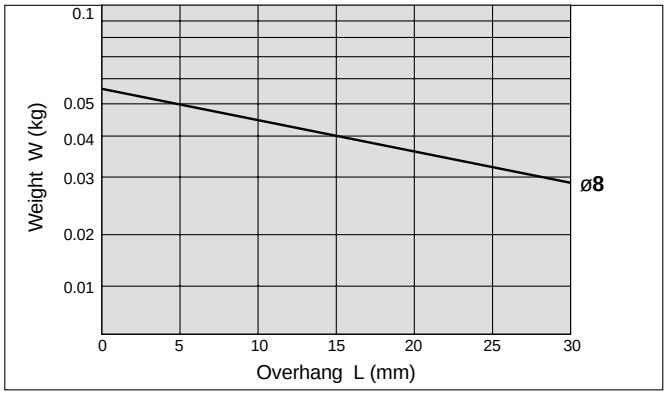


Horizontal Mounting

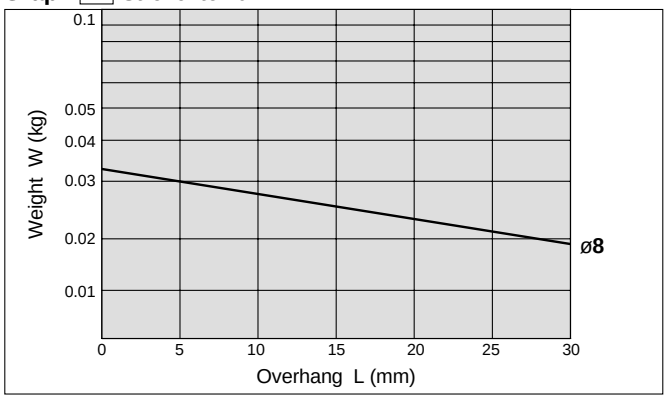
ø8

Maximum speed: to 300mm/s

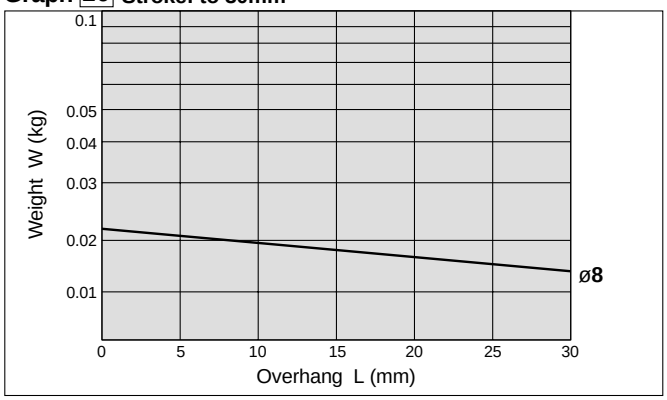
Graph 8 Stroke: to 10mm



Graph 9 Stroke: to 20mm

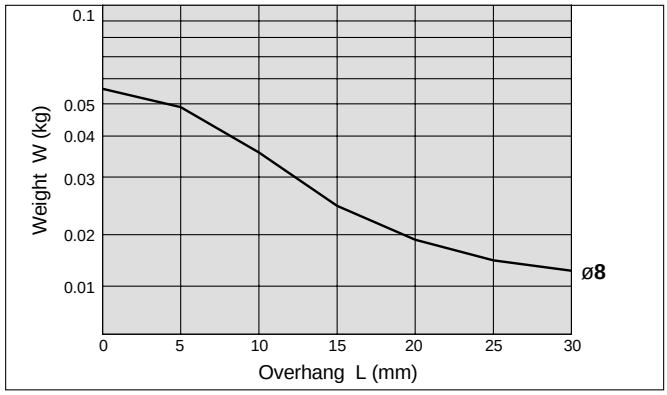


Graph 10 Stroke: to 30mm

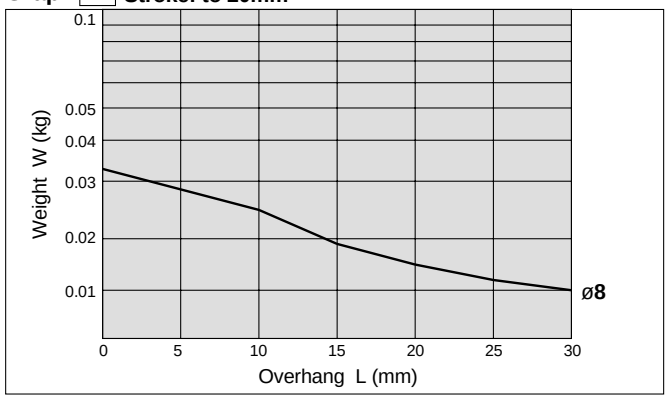


Maximum speed: to 500mm/s

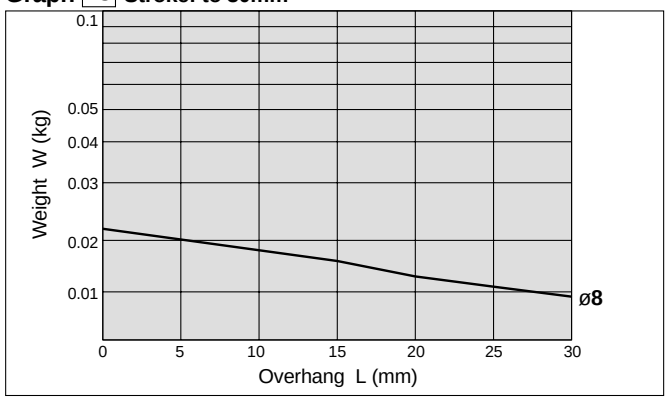
Graph 11 Stroke: to 10mm



Graph 12 Stroke: to 20mm



Graph 13 Stroke: to 30mm

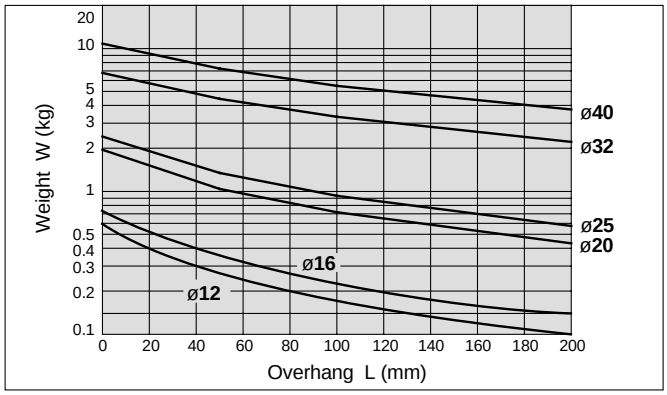


Horizontal Mounting

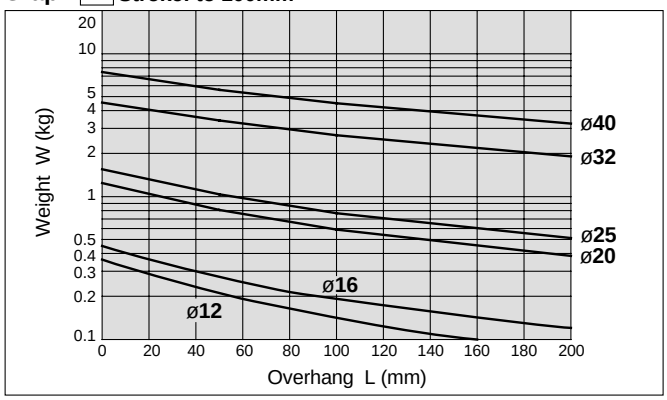
ø12 to ø40

Maximum speed: to 600mm/s

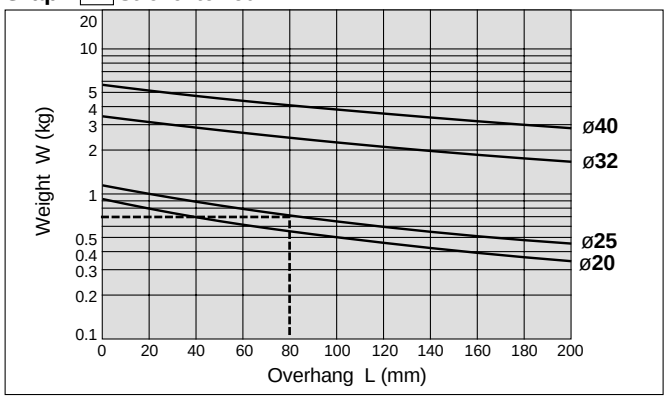
Graph 14 Stroke: to 50mm



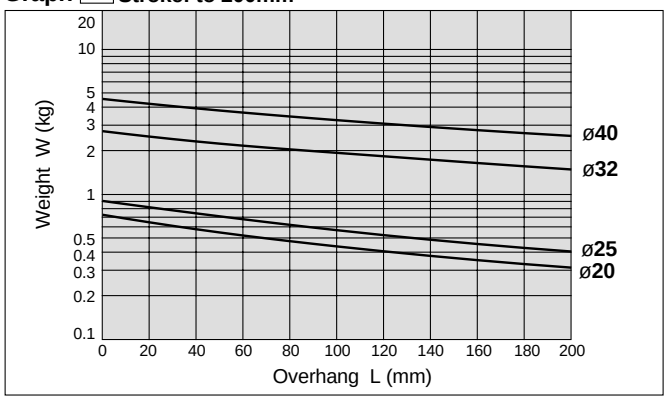
Graph 15 Stroke: to 100mm



Graph 16 Stroke: to 150mm

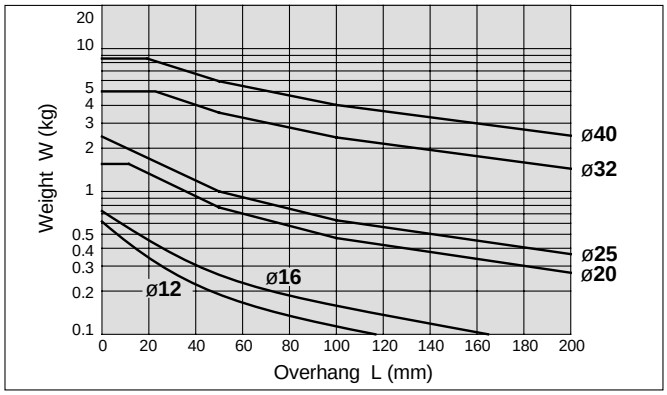


Graph 17 Stroke: to 200mm

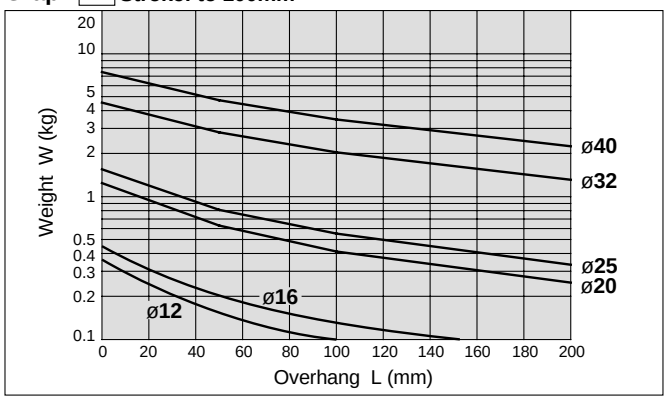


Maximum speed: to 800mm/s

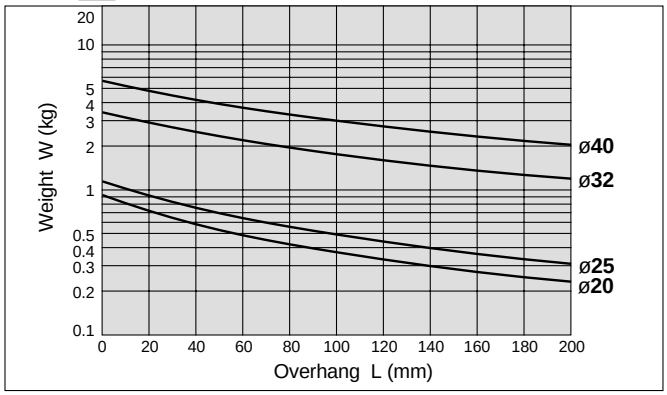
Graph 18 Stroke: to 50mm



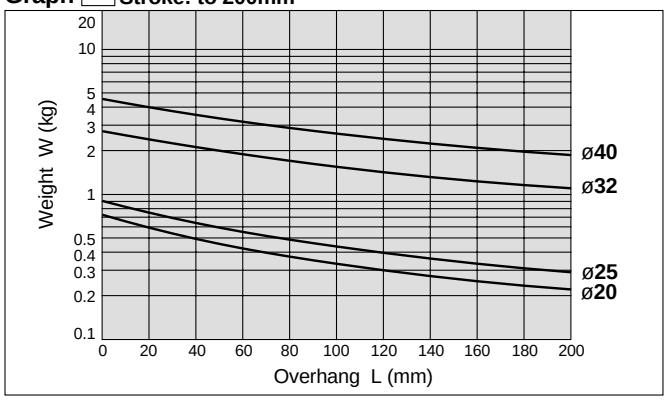
Graph 19 Stroke: to 100mm



Graph 20 Stroke: to 150mm



Graph 21 Stroke: to 200mm

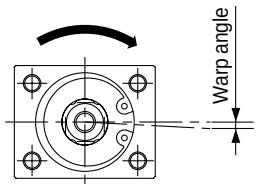


Spline Rod Displacement

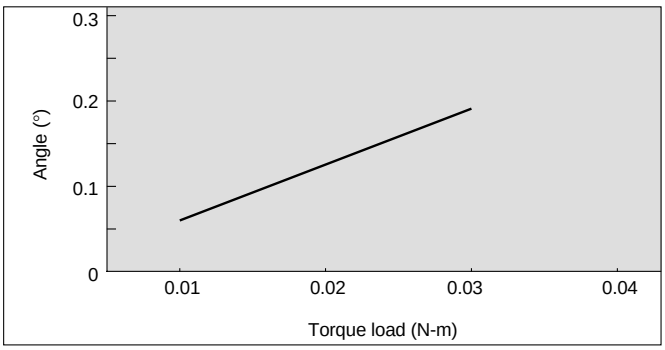
Warp Angle

Displacement angle of spline rod due to torque load

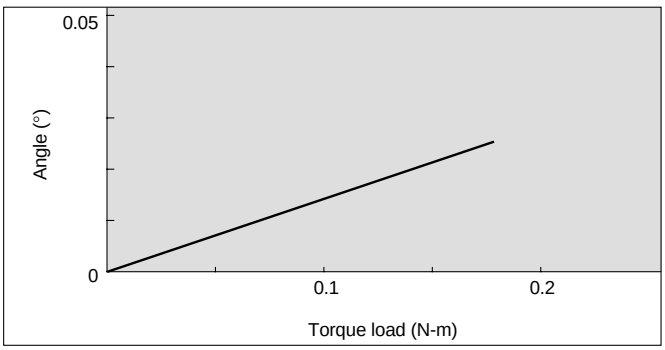
The displacement angle when a static load is applied in the direction of the arrow, with the spline rod retracted.



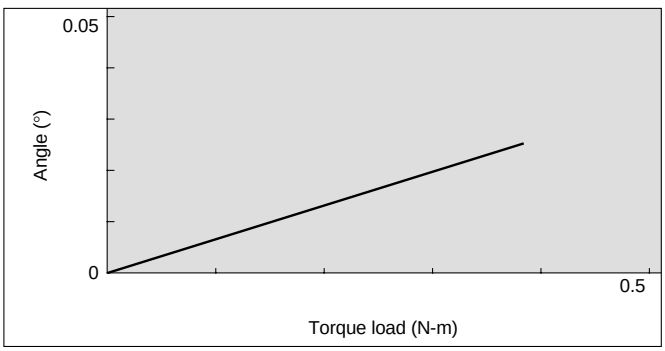
ø8



ø12



ø16



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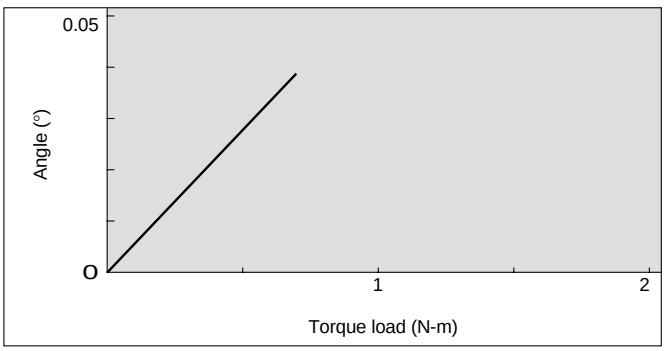
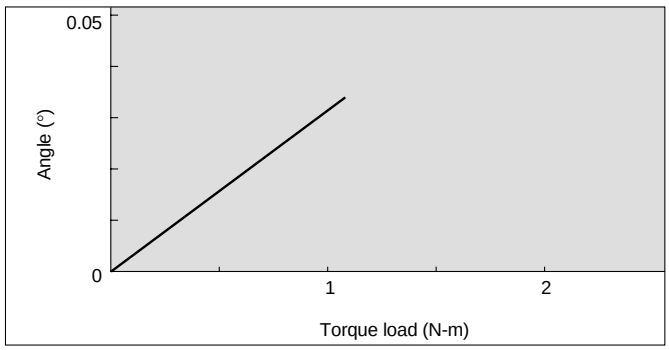
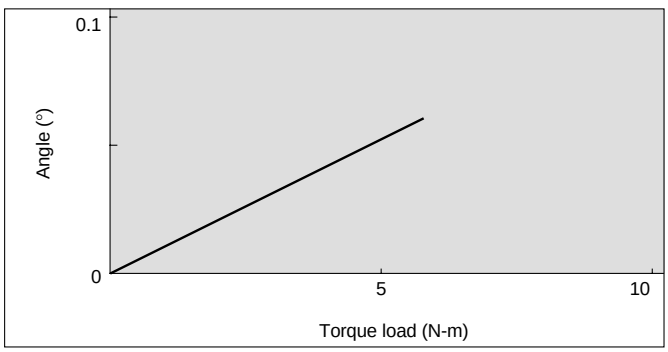


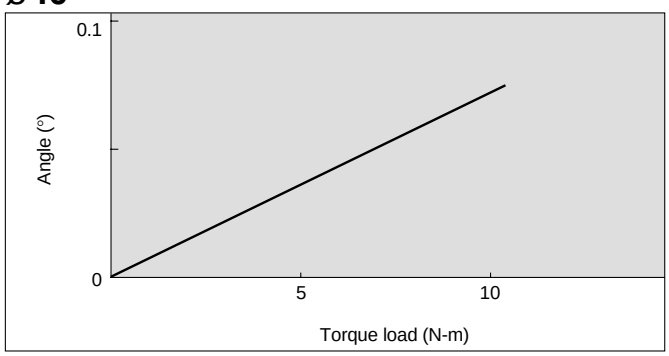
ø25



ø32



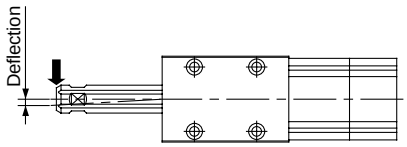
ø40



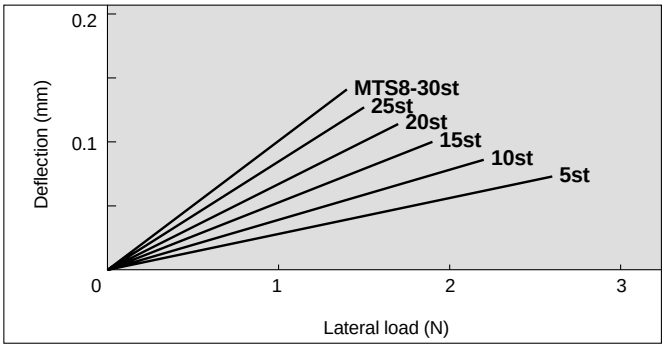
Deflection

Displacement of spline rod due to pitch moment load

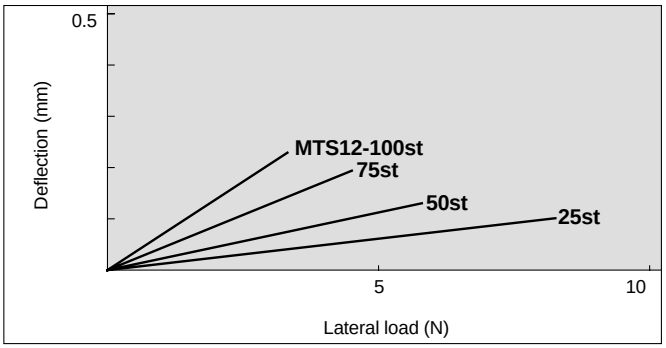
Displacement of the rod end when a static load is applied in the direction of the arrow, with the spline rod fully extended.



ø8



ø12



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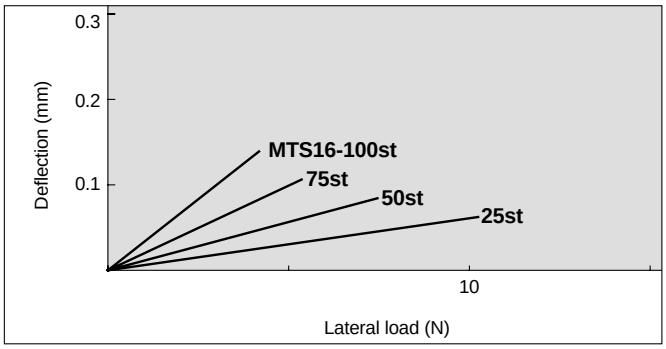
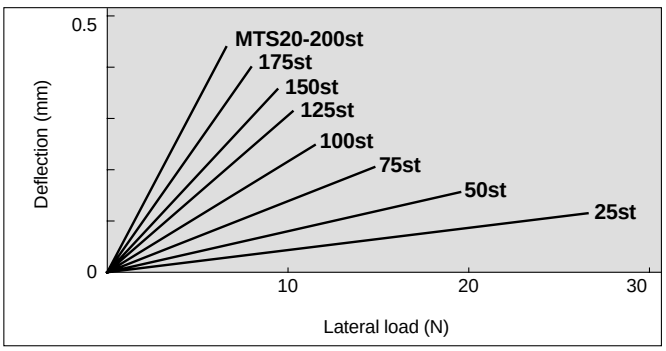


ø20



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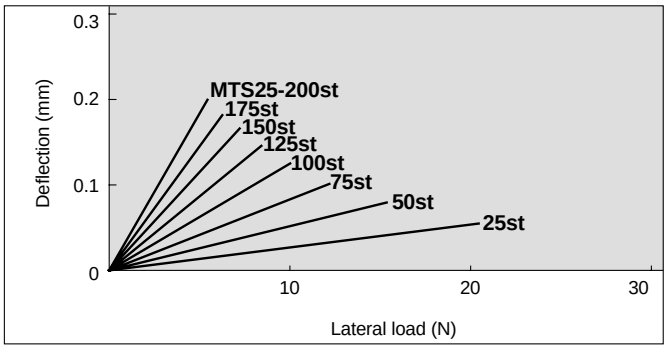

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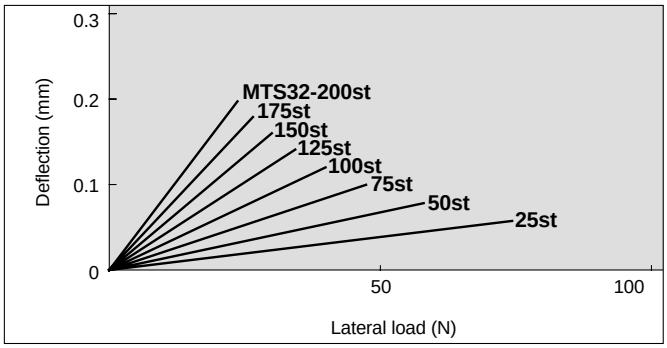

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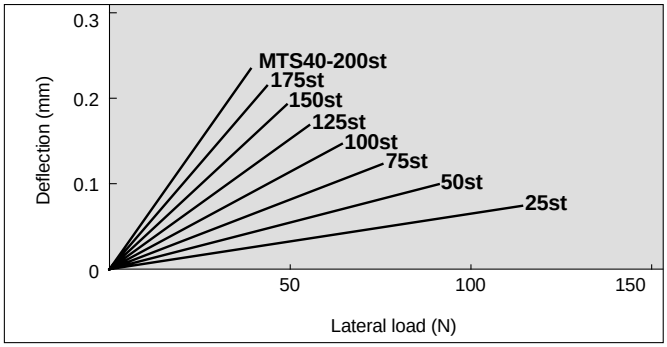


Design

⚠ Caution

1. Displacement may increase after an impact load has been applied.

If an impact load is applied to the spline rod, the guide unit may be permanently deformed and displacement may increase.

Series MTS
Safety Instructions

These safety instructions are intended to prevent a hazardous situation and/or equipment damage. These instructions indicate the level of potential hazard by a label of **"Caution", "Warning" or "Danger"**. To ensure safety, be sure to observe ISO 4414 Note 1), JIS B 8370 Note 2) and other safety practices.

⚠ Caution : Operator error could result in injury or equipment damage.

⚠ Warning : Operator error could result in serious injury or loss of life.

⚠ Danger : In extreme conditions, there is a possible result of serious injury or loss of life.

Note 1) ISO 4414: Pneumatic fluid power – Recommendations for the application of equipment to transmission and control systems.

Note 2) JIS B 8370: General Rules for Pneumatic Equipment

⚠ Warning

1. The compatibility of pneumatic equipment is the responsibility of the person who designs the pneumatic system or decides its specifications.

Since the products specified here are used in various operating conditions, their compatibility for the specific pneumatic system must be based on specifications or after analysis and/or tests to meet your specific requirements.

2. Only trained personnel should operate pneumatically operated machinery and equipment.

Compressed air can be dangerous if an operator is unfamiliar with it. Assembly, handling or repair of pneumatic systems should be performed by trained and experienced operators.

3. Do not service machinery/equipment or attempt to remove components until safety is confirmed.

1. Inspection and maintenance of machinery/equipment should only be performed after confirmation of safe locked-out control positions.
2. When equipment is to be removed, confirm the safety process as mentioned above. Cut the supply pressure for this equipment and exhaust all residual compressed air in the system.
3. Before machinery/equipment is restarted, take measures to prevent shooting-out of cylinder piston rod, etc. (Bleed air into the system gradually to create back-pressure.)

4. Contact SMC if the product is to be used in any of the following conditions:

1. Conditions and environments beyond the given specifications, or if product is used outdoors.
2. Installation on equipment in conjunction with atomic energy, railway, air navigation, vehicles, medical equipment, food and beverages, recreation equipment, emergency stop circuits, press applications, or safety equipment.
3. An application which has the possibility of having negative effects on people, property, or animals, requiring special safety analysis.

Series MTS
Actuator Precautions 1
Be sure to read before handling.

Design

⚠Warning

1. There is a danger of sudden action by air cylinders if sliding parts of machinery are twisted, etc., and changes in forces occur.

In such cases, human injury may occur; e.g., by catching hands or feet in the machinery, or damage to the machinery itself may occur. Therefore, the machinery should be designed to avoid such dangers.

2. Attach a protective cover when there is a danger of human injury.

If driven objects and moving parts of a cylinder present a danger of human injury, design the structure to avoid contact with the human body.

3. Securely tighten all stationary parts and connected parts so that they will not become loose.

Especially when a cylinder operates with high frequency or a cylinder is installed where there is a lot of vibration, ensure that all parts remain secure.

4. A deceleration circuit or shock absorber, etc., may be required.

When a driven object is operated at high speed or the load is heavy, a cylinder's cushion will not be sufficient to absorb the impact. Install a deceleration circuit to reduce the speed before cushioning, or install an external shock absorber to relieve the impact. In this case, the rigidity of the machinery should also be examined.

5. Consider a possible drop in circuit pressure due to a power outage, etc.

When a cylinder is used in a clamping mechanism, there is a danger of work pieces dropping if there is a decrease in clamping force due to a drop in circuit pressure caused by a power outage, etc. Therefore, safety equipment should be installed to prevent damage to machinery and human injury. Suspension mechanisms and lifting devices also require consideration for drop prevention.

6. Consider a possible loss of power source.

Measures should be taken to protect against human injury and equipment damage in the event that there is a loss of power to equipment controlled by air pressure, electricity or hydraulics, etc.

7. Design circuitry to prevent sudden lurching of driven objects.

When a cylinder is driven by an exhaust center type directional control valve or when starting up after residual pressure is exhausted from the circuit, etc., the piston and its driven object will lurch at high speed if pressure is applied to one side of the cylinder because of the absence of air pressure inside the cylinder. Therefore, equipment should be selected and circuits designed to prevent sudden lurching, because there is a danger of human injury and/or damage to equipment when this occurs.

8. Consider emergency stops.

Design so that human injury and/or damage to machinery and equipment will not be caused when machinery is stopped by a safety device under abnormal conditions, a power outage or a manual emergency stop.

9. Consider the action when operation is restarted after an emergency stop or abnormal stop.

Design the machinery so that human injury or equipment damage will not occur upon restart of operation. When the cylinder has to be reset at the starting position, install safe manual control equipment.

Selection

⚠Warning

1. Confirm the specifications.

The products advertised in this catalog are designed according to use in industrial compressed air systems. If the products are used in conditions where pressure, temperature, etc., are out of specification, damage and/or malfunction may be caused. Do not use in these conditions. (Refer to specifications.)

Consult SMC if you use a fluid other than compressed air.

2. Intermediate stops

When intermediate stopping of a cylinder piston is performed with a 3 position closed center type directional control valve, it is difficult to achieve stopping positions as accurate and minute as with hydraulic pressure due to the compressibility of air.

Furthermore, since valves and cylinders, etc., are not guaranteed for zero air leakage, it may not be possible to hold a stopped position for an extended period of time. Contact SMC in case it is necessary to hold a stopped position for an extended period.

⚠Caution

1. Operate within the limits of the maximum usable stroke.

The spline rod will be damaged if operated beyond the maximum stroke. Refer to the air cylinder model selection procedure for the maximum usable stroke.

2. Operate the piston within a range such that collision damage will not occur at the stroke end.

Operate within a range such that damage will not occur when the piston having inertial force stops by striking the cover at the stroke end. Refer to the cylinder model selection procedure for the range within which damage will not occur.

3. Use a speed controller to adjust the cylinder drive speed, gradually increasing from a low speed to the desired speed setting.

Series MTS
Actuator Precautions 2
Be sure to read before handling.

Mounting

⚠Caution

1. Be sure to perform connection so that the rod axis coincides with the load and the direction of movement.

If it does not coincide, twisting will occur in the spline rod and tube, causing abrasion and damage in areas such as the inner surface of the tube, the bearings, the surface of the spline rod and the seals.

2. Do not scratch or gouge the sliding parts of the cylinder tube or spline rod, etc., by striking or grasping them with other objects.

Cylinder bores are manufactured to precise tolerances, so that even a slight deformation may cause faulty operation. Also, scratches or gouges, etc., in the spline rod may lead to damaged seals and cause air leakage.

3. When attaching a work piece to the end of the spline rod, the spline rod should be fully retracted, and tightening should be performed using the wrench flats at the end of the spline rod so that it is not subjected to excessive torque.

4. Do not use until you can verify that equipment can operate properly.

Following mounting, maintenance or conversions, verify correct mounting by suitable function and leakage tests after compressed air and power are connected.

5. Instruction manual

The product should be mounted and operated after thoroughly reading the manual and understanding its contents.
Keep the instruction manual where it can be referred to as needed.

Piping

⚠Caution

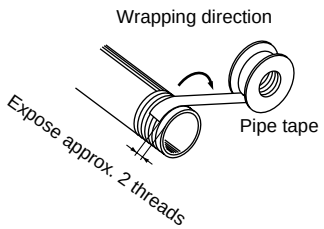
1. Preparation before piping

Before piping is connected, it should be thoroughly blown out with air (flushing) or washed to remove chips, cutting oil and other debris from inside the pipe.

2. Wrapping of pipe tape

When screwing together pipes and fittings, etc., be certain that chips from the pipe threads and sealing material do not get inside the piping.

Also, when pipe tape is used, leave 1.5 to 2 thread ridges exposed at the end of the threads.



Cushion

⚠Caution

1. Readjust the cushion using the cushion needle.

The cushion is adjusted at the time of shipment, however, the cushion needle installed on the cover should be readjusted when the product is put into use, in accordance with the size of the load and the operating speed, etc. When the cushion needle is turned clockwise, the throttle becomes smaller and the effectiveness of the cushion becomes greater.

2. Do not use the product with the cushion needle fully closed.

This can cause damage to the seals.

Lubrication

⚠Caution

1. Lubrication of non-lube type cylinder

The cylinder is lubricated at the factory and can be used without any further lubrication.

However, in the event that it will be lubricated, use class 1 turbine oil (with no additives) ISO VG32.

Stopping lubrication later may lead to malfunction due to the loss of the original lubricant. Therefore, lubrication must be continued once it has been started.

Air Supply

⚠Warning

1. Use clean air.

Do not use compressed air including chemicals, synthetic oils containing organic solvents, salt or corrosive gases, etc., as it can cause damage or malfunction.

⚠Caution

1. Install air filters.

Install air filters at the upstream side of valves. The filtration degree should be 5µm or finer.

2. Install an air dryer, after-cooler or water separator, etc.

Air that includes excessive drainage may cause malfunction of valves and other pneumatic equipment. To prevent this, install an air dryer, after-cooler or water separator, etc.

3. Use the product within the specified fluid and ambient temperature range.

Take measures to prevent freezing when temperatures are 5°C or less, since moisture in circuits can be frozen, and this may cause damage to seals and lead to malfunction.

Refer to SMC's "Air Cleaning Equipment" catalog for further details on compressed air quality.

Series MTS
Actuator Precautions 3
Be sure to read before handling.

Operating Environment

⚠Warning

1. Do not use in environments where there is a danger of corrosion.

Refer to the construction drawings regarding cylinder materials.

2. In dusty locations or where water, oil, etc., splash on the equipment, take suitable measures to protect the rod.

Maintenance

⚠Warning

1. Perform maintenance according to the procedure indicated in the instruction manual.

If handled improperly, malfunction and damage of machinery or equipment may occur.

2. Removal of machinery, and supply/exhaust of compressed air

When machinery is removed, first check measures to prevent dropping of driven objects and run-away of equipment, etc. Then cut off the supply pressure and electric power, and exhaust all compressed air from the system.

When machinery is restarted, proceed with caution after confirming measures to prevent cylinder lurching.

⚠Caution

1. Drain flushing

Remove drainage from air filters regularly.
(Refer to specifications.)

Series MTS
Auto Switch Precautions 1
Be sure to read before handling.

Design and Selection

⚠Warning

1. Confirm the specifications.

Read the specifications carefully and use the product appropriately. The product may be damaged or malfunction if it is used outside the range of specifications of load current, voltage, temperature or impact.

2. Take precautions when multiple cylinders are used close together.

When multiple auto switch cylinders are used in close proximity, magnetic field interference may cause the switches to malfunction. Refer to “Using Cylinders in Close Proximity to One Another” on page 13.

3. Pay attention to the time that a switch is ON at an intermediate stroke position.

When an auto switch is placed at an intermediate position of the stroke and a load is driven when the piston passes, the auto switch will operate, but if the speed is too great the operating time will be shortened and the load may not operate properly. The maximum detectable piston speed is:

$$V(mm/s) = \frac{\text{Auto switch operating range (mm)}}{\text{Load operating time (ms)}} \times 1000$$

4. Keep wiring as short as possible.

<Reed switch>

As the length of the wiring to a load gets longer, the rush current at switching ON becomes greater, and this may shorten the product’s life. (The switch will stay ON all the time.)

1) Use a contact protection box when the wire length is 5m or longer.

<Solid state switch>

2) Although wire length should not affect switch function, use a wire 100m or shorter.

5. Take precautions for the internal voltage drop of the switch.

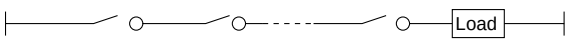
<Reed switch>

1) Switches with an indicator light (except D-A96/A96V)

- If auto switches are connected in series as shown below, take note that there will be a large voltage drop because of internal resistance in the light emitting diode. (Refer to internal voltage drop in the auto switch specifications.)

  [The voltage drop will be “n” times larger when “n” auto switches are connected.]

  Even though an auto switch operates normally, the load may not operate.



- In the same way, when operating below a specified voltage, although an auto switch may operate normally, the load may not operate. Therefore, the formula below should be satisfied after confirming the minimum operating voltage of the load.

  Supply voltage − Internal voltage drop of switch > Minimum operating voltage of load

2) If the internal resistance of a light emitting diode causes a problem, select a switch without an indicator light (model A90, A90V).

<Solid state switch>

3) Generally, the internal voltage drop will be greater with a 2 wire solid state auto switch than with a reed switch. Take the same precautions as in 1).

   Also, note that a 12VDC relay is not applicable.

6. Pay attention to leakage current.

<Solid state switch>

With a 2 wire solid state auto switch, current (leakage current) flows to the load to operate the internal circuit even when in the OFF state.

Operating current of load (OFF condition) > Leakage current

If the criteria given in the above formula are not met, it will not reset correctly (stays ON). Use a 3 wire switch if this specification will not be satisfied.

Moreover, leakage current flow to the load will be “n” times larger when “n” auto switches are connected in parallel.

7. Do not use a load that generates surge voltage.

<Reed switch>

If driving a load such as a relay that generates a surge voltage, use a contact protection box.

<Solid state switch>

Although a zener diode for surge protection is connected at the output side of a solid state auto switch, damage may still occur if the surge is applied repeatedly. When directly driving a load which generates surge, such as a relay or solenoid, use a type of switch with a built-in surge absorbing element.

8. Cautions for use in an interlock circuit

When an auto switch is used for an interlock signal requiring high reliability, devise a double interlock system to avoid trouble by providing a mechanical protection function, or by also using another switch (sensor) together with the auto switch. Also perform periodic maintenance and confirm proper operation.

9. Ensure sufficient clearance for maintenance activities.

When designing an application, be sure to allow sufficient clearance for maintenance and inspections.

Series MTS
Auto Switch Precautions 2
Be sure to read before handling.

Mounting and Adjustment

⚠Warning

1. Do not drop or bump.

Do not drop, bump or apply excessive impacts (300m/s² or more for reed switches and 1000m/s² or more for solid state switches) while handling. Although the body of the switch may not be damaged, the inside of the switch could be damaged and cause a malfunction.

2. Do not carry a cylinder by the auto switch lead wires.

Never carry a cylinder by its lead wires. This may not only cause broken lead wires, but it may cause internal elements of the switch to be damaged by the stress.

3. Mount switches using the proper fastening torque.

When a switch is tightened beyond the range of fastening torque, the mounting screws or switch may be damaged. On the other hand, tightening below the range of fastening torque may allow the switch to slip out of position.

4. Mount a switch at the center of the operating range.

Adjust the mounting position of an auto switch so that the piston stops at the center of the operating range (the range in which a switch is ON).

(The mounting positions shown in the catalog indicate the optimum position at stroke end.) If mounted at the end of the operating range (around the borderline of ON and OFF), operation may be unstable.

Wiring

⚠Warning

1. Avoid repeatedly bending or stretching lead wires.

Broken lead wires will result from wiring patterns which repeatedly apply bending stress or stretching force to the lead wires.

2. Be sure to connect the load before power is applied.

<2 wire type>

If the power is turned ON when an auto switch is not connected to a load, the switch will be instantly damaged because of excess current.

3. Confirm proper insulation of wiring.

Be certain that there is no faulty wiring insulation (contact with other circuits, ground fault, improper insulation between terminals, etc.). Damage may occur due to excess current flow into a switch.

4. Do not wire with power lines or high voltage lines.

Wire separately from power lines or high voltage lines, avoiding parallel wiring or wiring in the same conduit with these lines. Control circuits containing auto switches may malfunction due to noise from these other lines.

Wiring

⚠Warning

5. Do not allow short circuit of loads.

<Reed switches>

If the power is turned ON with a load in a short circuited condition, the switch will be instantly damaged because of excess current.

<Solid state switches>

D-F9□(V), D-F9□W(V) and all models of PNP output type switches do not have built-in short circuit protection circuits. If loads are short circuited, the switches will be instantly damaged, as in the case of reed switches.

Take special care to avoid reverse wiring with the brown [red] power supply line and the black [white] output line on 3 wire type switches.

6. Avoid incorrect wiring.

<Reed switches>

A 24VDC switch with indicator light has polarity. The brown [red] lead wire is (+), and the blue [black] lead wire is (–).

1) If connections are reversed, a switch will operate, however, the light emitting diode will not light up.

   Also note that a current greater than that specified will damage a light emitting diode and it will no longer operate.

   Applicable models: D-A93/A93V

<Solid state switches>

1) If connections are reversed on a 2 wire type switch, the switch will not be damaged if protected by a protection circuit, but the switch will always stay in an ON state. However, it is still necessary to avoid reversed connections, since the switch could be damaged by a load short circuit in this condition.
2) If connections are reversed (power supply line + and power supply line –) on a 3 wire type switch, the switch will be protected by a protection circuit. However, if the power supply line (+) is connected to the blue [black] wire and the power supply line (–) is connected to the black [white] wire, the switch will be damaged.

∗ Lead wire color changes

Lead wire colors of SMC switches have been changed in order to meet NECA Standard 0402 for production beginning September, 1996 and thereafter. Please refer to the tables provided.
Special care should be taken regarding wire polarity during the time that the old colors still coexist with the new colors.

2 wire

	Old	New
Output (+)	Red	Brown
Output (–)	Black	Blue

3 wire

	Old	New
Power supply	Red	Brown
GND	Black	Blue
Output	White	Black

Solid state with diagnostic output

	Old	New
Power supply	Red	Brown
GND	Black	Blue
Output	White	Black
Diagnostic output	Yellow	Orange

Solid state with latch type diagnostic output

	Old	New
Power supply	Red	Brown
GND	Black	Blue
Output	White	Black
Latch type diagnostic output	Yellow	Orange

Note) Lead wire colors inside [ ] are those prior to conformity with NECA standards.

Series MTS
Auto Switch Precautions 3
Be sure to read before handling.

Operating Environment

⚠Warning

1. Never use in an atmosphere of explosive gases.

The construction of auto switches is not intended to prevent explosion. Never use in an atmosphere with an explosive gas since this may cause a serious explosion.

2. Do not use in an area where a magnetic field is generated.

Auto switches will malfunction or magnets inside cylinders will become demagnetized. (Consult SMC regarding the availability of a magnetic field resistant auto switch.)

3. Do not use in an environment where the auto switch will be continually exposed to water.

Although switches, except for some models, satisfy IEC standard IP67 construction (JIS C 0920: watertight construction), do not use switches in applications where continually exposed to water splash or spray. Poor insulation or swelling of the potting resin inside switches may cause malfunction.

4. Do not use in an environment with oil or chemicals.

Consult SMC if auto switches will be used in an environment with coolant, cleaning solvent, various oils or chemicals. If auto switches are used under these conditions for even a short time, they may be adversely affected by improper insulation, malfunction due to swelling of the potting resin, or hardening of the lead wires.

5. Do not use in an environment with temperature cycles.

Consult SMC if switches are used where there are temperature cycles other than normal air temperature changes, as they may be adversely affected internally.

6. Do not use in an environment where there is excessive impact shock.

<Reed switches>

When excessive impact (300m/s² or more) is applied to a reed switch during operation, the contact point may malfunction and generate or cut off a signal momentarily (1ms or less). Consult SMC regarding the need to use a solid state switch depending upon the environment.

7. Do not use in an area where surges are generated.

<Solid state switches>

When there are units (solenoid type lifter, high frequency induction furnace, motor, etc.) which generate a large amount of surge in the area around cylinders with solid state auto switches, this may cause deterioration or damage to the switch. Avoid sources of surge generation and crossed lines.

8. Avoid accumulation of iron waste or close contact with magnetic substances.

When a large amount of ferrous waste such as machining chips or spatter is accumulated, or a magnetic substance (something attracted by a magnet) is brought into close proximity with an auto switch cylinder, it may cause the auto switch to malfunction due to a loss of the magnetic force inside the cylinder.

Maintenance

⚠Warning

1. Perform the following maintenance periodically in order to prevent possible danger due to unexpected auto switch malfunction.

1) Securely tighten switch mounting screws.
If screws become loose or the mounting position is dislocated, retighten them after readjusting the mounting position.

2) Confirm that there is no damage to lead wires.
To prevent faulty insulation, replace switches or repair lead wires, etc., if damage is discovered.

3) Confirm lighting of the green light on 2 color indication switches.
Confirm that the green LED is on when stopped at the established position. If the red LED is on, the mounting position is not appropriate. Readjust the mounting position until the green LED lights up.

Other

⚠Warning

1. Consult SMC concerning water resistance, elasticity of lead wires and usage at welding sites, etc.

Use of the End Lock Type

Operation

⚠Caution

1. Do not use 3 position solenoid valves.

Avoid use in combination with 3 position solenoid valves (especially closed center metal seal types). If pressure is trapped in the port on the lock mechanism side, the cylinder cannot be locked.

Furthermore, even after being locked, the lock may be released after some time, due to air leaking from the solenoid valve and entering the cylinder.

2. Back pressure is required when releasing the lock.

Before starting operation, be sure to control the system so that air is supplied to the side without the lock mechanism. There is a possibility that the lock may not be released. (Refer to the section on releasing the lock.)

3. Release the lock when mounting or adjusting the cylinder.

If mounting or other work is performed when the cylinder is locked, the lock unit may be damaged.

4. Operate with a load ratio of 50% or less.

If the load ratio exceeds 50%, this may cause problems such as failure of the lock to release, or damage to the lock unit.

5. Do not operate multiple synchronized cylinders.

Avoid applications in which two or more end lock cylinders are synchronized to move one workpiece, as one of the cylinder locks may not be able to release when required.

6. Use a speed controller with meter-out control.

It may not be possible to release the lock with meter-in control.

7. Be sure to operate completely to the cylinder stroke end on the side with the lock.

If the cylinder piston does not reach the end of the stroke, locking and unlocking may not be possible.

Operating Pressure

⚠Caution

1. Apply air pressure of at least that shown in the table below to the port on the lock mechanism side. This is necessary to release the lock.

Bore size (mm)	Operating pressure MPa
12, 16	0.17
20, 25, 32, 40	0.15

Exhaust Speed

⚠Caution

1. Locking will occur automatically if the pressure applied to the port on the lock mechanism side falls to 0.05MPa or less. In cases where the piping on the lock mechanism side is long and thin, or the speed controller is separated at some distance from the cylinder port, the exhaust speed will be reduced. Take note that some time may be required for the lock to engage.
In addition, clogging of a silencer mounted on the solenoid valve EXH. port will also produce the same effect.

Relationship with the Cushion

⚠Caution

1. When the cushion valve on the lock mechanism side is closed or nearly closed, the spline rod may not reach the stroke end, and consequently the lock may not engage.
Moreover, if the lock does engage when the cushion valve is nearly closed, it may not be possible for the lock to release. Therefore, the cushion valve should be adjusted properly.

Releasing the Lock

⚠Warning

1. Before releasing the lock, be sure to supply air to the side without the lock mechanism, so that there is no load applied to the lock mechanism when it is released. If the lock is released when the port on the other side is in an exhaust state, and with a load applied to the lock unit, the lock unit may be subjected to an excessive force and be damaged.
Furthermore, sudden movement of the spline rod is very dangerous.

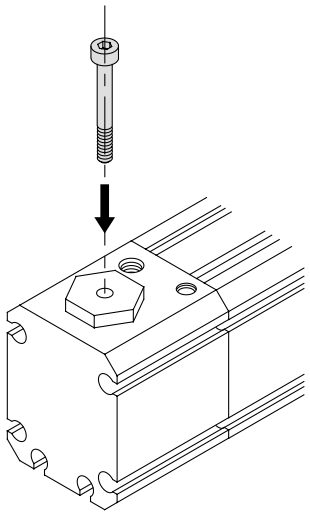
Manual Release

⚠Caution

1. Insert the bolt, screw it into the lock piston, and then pull it to release the lock. If you stop pulling the bolt, the lock will return to an operational state. Thread sizes, pulling forces and strokes are as shown below.

Bore size (mm)	Thread size	Pulling force N	Stroke (mm)
12, 16	M2 x 0.4 x 15ℓ or more	2	1.5
20, 25, 32	M3 x 0.5 x 30ℓ or more	3	2
40	M3 x 0.5 x 30ℓ or more	4	3

∗ Remove the bolt for normal operation.
It can cause lock malfunction or faulty release.



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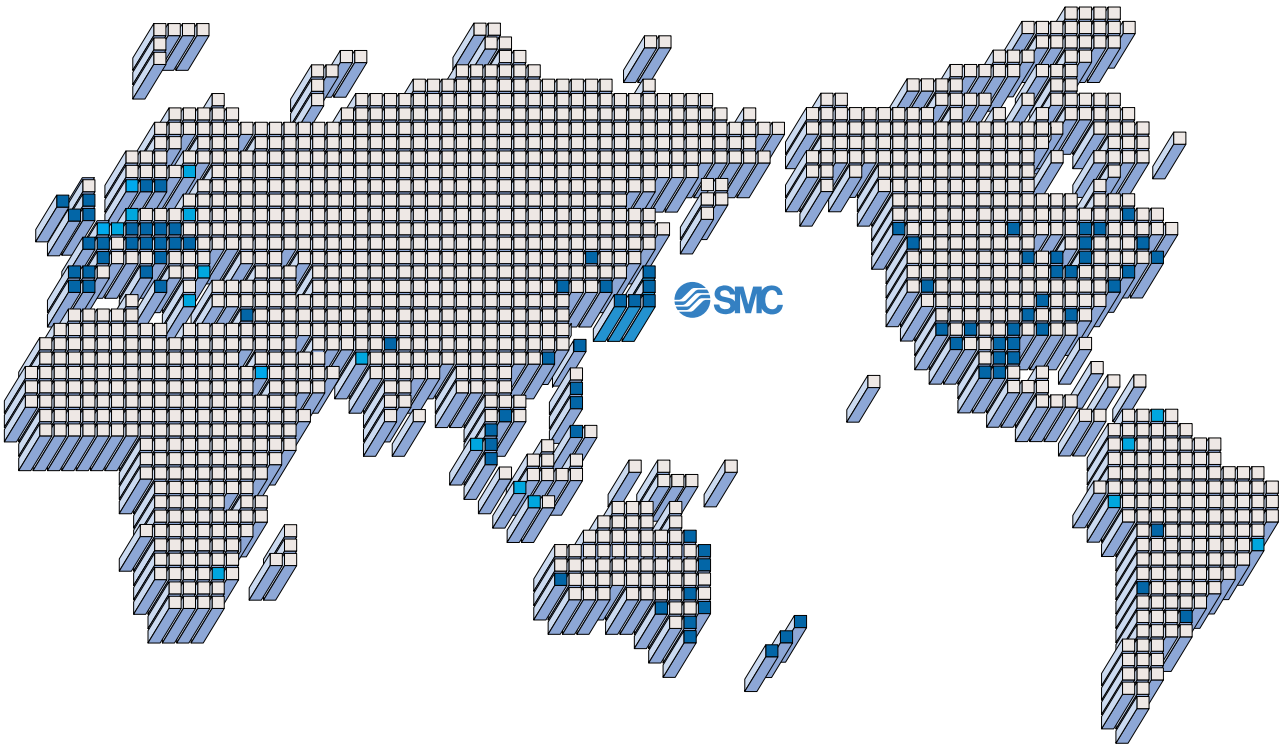

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